Joint Council on Food
and Agricultural Sciences

November 1988

1988 Accomplishments for Research, Extension, and Higher Education

A Report to the Secretary of Agriculture

The Joint Council on Food and Agricultural Sciences was established by Congress in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences throughout the United States. Its members, who are from both the public and private sectors, represent producers, industry, and State and Federal agencies and institutions. The Council's role was strengthened in the 1981 Agriculture and Food Act, which directed the Department to improve the planning and coordination of research, extension, and higher education within both the public and private sectors and to relate the Federal budgeting process to the overall functioning of the system. The Joint Council's responsibilities were reaffirmed in the Food Security Act of 1985.

In 1984 the Joint Council published a long-term (20 years) *Needs Assessment* of the food, fiber, and forestry products sectors, with particular emphasis on the supporting role of the food and agricultural science and education system. This report was published in two volumes: *Reference Document: Needs Assessment for the Food and Agricultural Sciences*; and *Summary: Needs Assessment for the Food and Agricultural Sciences*. The congressionally mandated responsibilities and the material in these two documents provide the foundation for the Joint Council's activities.

The Joint Council prepares three other reports to meet its coordination and planning responsibilities. A *Five-Year Plan* reflects the issues and challenges that the food, fiber, and agricultural production system will face during the next five years and the goals and objectives necessary to adequately address them. The *Five-Year Plan*, initially published in 1984, is updated biennially. It provides overall guidance and direction to the food and agricultural science and education system within the U.S. Department of Agriculture and its cooperating institutions.

The Council's *Priorities Report* outlines the current national emphases of research, extension, and higher education programs in the food and agricultural sciences. This annual report presents ranked national priorities for the next fiscal year.

The annual *Accomplishments Report* provides examples of both long-term and current accomplishments of the research, extension, and higher education programs, including interagency and interdisciplinary activities.

These three reports constitute an overall strategic planning and review process. This process facilitates and enhances the coordination, planning, and financial relationships through which short-term and longer term future needs are defined, goals and objectives are established, and accomplishments are noted. The reports provide the foundation for planning an efficient and effective means for meeting the future national and international demands for food, fiber, and forest products.

The Joint Council symbol represents the Council's primary responsibility: to improve coordination and planning among research, extension, and higher education programs. It also characterizes the cooperative spirit that exists among the Federal, State, and private organizations and institutions within the food and agricultural science and education system.

Joint Council on Food and Agricultural Sciences

Secretariat:
Suite 302 Aerospace Building
U.S. Department of Agriculture
Washington, D.C. 20250-2200

November 30, 1988

Honorable Richard E. Lyng
Secretary of Agriculture
Washington, DC 20250

Dear Mr. Secretary:

On behalf of the Joint Council on Food and Agricultural Sciences, we are pleased to convey to you the 1988 Accomplishments for Research, Extension and Higher Education. As you know, Section 1407, Public Law 95-113, as amended by Public Law 97-98, requires the Joint Council to provide you with an annual summary of the progress that the food and agricultural science and education system has made.

As in last year's report, we continue to emphasize longer term accomplishments and those arising from cooperative undertakings. The accomplishments noted are but a small sampling of the more than 400 that were submitted to and considered by the National Committees (Agricultural Research, Extension, and Higher Education). The National Committees reviewed those and in turn submitted a smaller number to the Joint Council which reviewed and then selected the sampling included in this report. A summary of the activities and accomplishments of the Joint Council, the National Committees, and the Regional Councils are also included.

We look forward to discussing this report with you.

Sincerely,

Orville G. Bentley
ORVILLE G. BENTLEY
Cochair

Charles E. Hess
CHARLES E. HESS
Cochair

Enclosure

1988 Accomplishments for Research, Extension, and Higher Education

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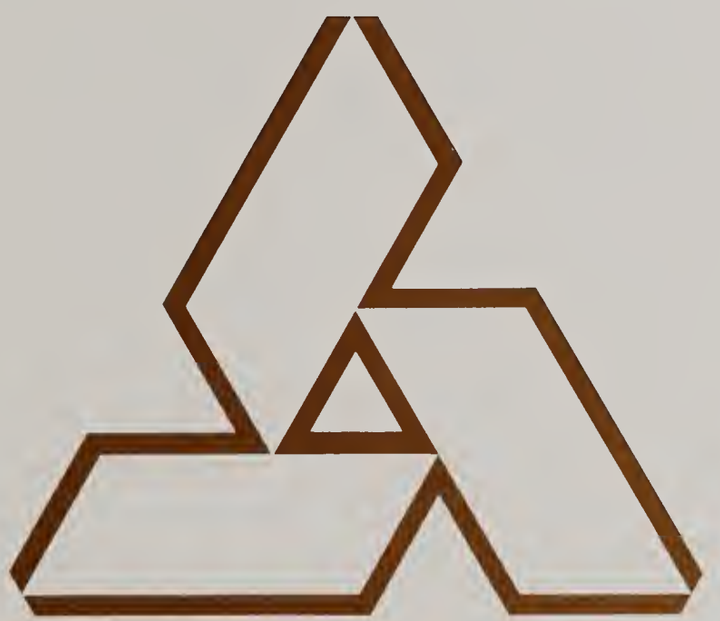

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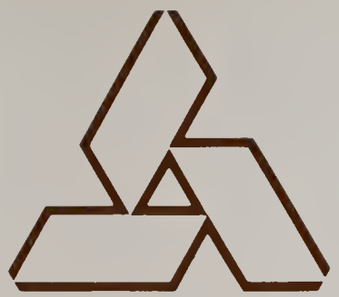
Editorial services were provided by Mary Ann Wamsley, Information Impact . A. Marie Salter, CSRS, provided typing and numerous other services. Larry R. Miller, previously the Joint Council Executive Secretary and now with the Cooperative State Research Service, gave insightful and vital counsel and assistance during the preparation of this report.



Introduction

The Joint Council on Food and Agricultural Sciences is charged with improving planning and coordination within the food and agricultural science and education system. Through this system, resources are directed toward food, agricultural, and forestry-related problems and opportunities. The research, extension, and higher education entities that make up the system have developed and transferred the knowledge and experiences that underpin the U.S. agricultural production system.

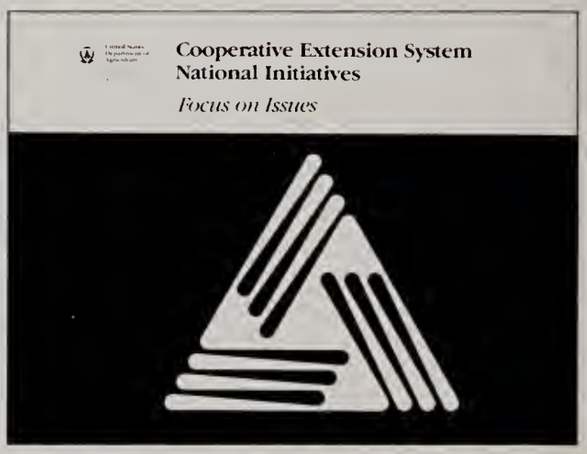
Although some parts of the Nation were adversely affected by the recent drought, the agricultural sector has, for the most part, weathered the hard economic times of the early and mid-1980's. The knowledge and assistance provided by the food and agricultural science and education system helped in making the necessary adjustments. The agricultural turn-around has been aided by the system's commitment to programs dedicated to making U.S. agriculture more productive, less costly to the producer, less expensive to the consumer, and more cognizant of the realities within the international marketplace. The increase in food and agricultural scientific knowledge has not occurred overnight—it is the result of decades of substantial public and private investments in people, facilities, research, extension, and higher education programs and initiatives.

This *1988 Accomplishments Report for Research, Extension, and Higher Education* summarizes the achievements of the food and agricultural science and education system during the past year in three categories: long-term accomplishments, accomplishments from cooperative activities, and current accomplishments.

Research programs funded by competitive grants continue to enhance base programs in universities and Federal laboratories. Most of these programs are fundamental studies concerning the interactions between living things and their environments. This research is improving the efficiency with which the Nation's resources are utilized; expanding scientific knowledge and expertise; and generating more economically vibrant and competitive food, agricultural, and forestry sectors. The increased emphasis on cooperative undertakings involving Federal agencies, universities, and private businesses is also speeding the transfer of new knowledge to users.

The Extension system continues to establish national initiatives that define the areas which will receive the highest priority for new and reallocated resources. A new strategic planning process will help Extension readily identify future areas of concern for possible inclusion as additional high-priority initiatives.

Higher Education programs continue to focus on improving agriculture-related curriculums and on attracting academically talented students. Increasing attention to the needs of both students and employers is leading to innovative academic programs. Innovative efforts to attract minority faculty and students are also continuing with increasing success. The student recruitment effort is focusing on the need to provide secondary teachers and guidance counselors with better information about career opportunities in agriculture.



An accomplishment that is reported one year often is the result of efforts that span a number of years. Most of the long-term accomplishments reported here reflect 3 to 5 years of effort. They represent both public and private efforts, a wide array of scientific disciplines, and, in some cases, interdisciplinary cooperation.

Using Biotechnology To Decrease Costs While Increasing Crop Protection*

Biological Stress: Since the first successful transformation and regeneration of tobacco plants only 5 years ago, a major focus of recombinant DNA technology has been to develop plants that resist viruses, pathogens, and insects. Sandoz Corporation scientists at Palo Alto, California, have developed a system for transforming and regenerating maize plants from denuded maize cells, called protoplasts. Foreign DNA has been delivered into protoplasts both by pulsing the cells with high voltage to create pores through which the DNA could enter the cells and by using high-velocity microprojectiles of tungsten on which DNA was adsorbed. In both cases the cells showed high expression of the foreign genes. Whole plants regenerated from the protoplasts also exhibit the presence of the foreign genes. This research leads the way for genetically modifying corn plants with genes that improve crop protection and lower costs of production.

Transforming Crop Plants for Defense Against Viruses: One of the most exciting and practical advances in plant-related recombinant DNA technology has been the development of virus resistance in some crop plants. Crop plants have little or no natural resistance to the many virus strains, and no chemicals are directly effective against virus infections in plants. Scientists from Monsanto and Washington University, St. Louis, have introduced a viral "coat protein" gene into tobacco and tomato and have shown that the expressed gene —a single-gene product — inhibits infection by the tobacco and tomato mosaic viruses. This experiment, along with others conducted in greenhouses and in fields, indicates that this approach can be used to genetically engineer viral protection into many agricultural crops. The technique has already been used successfully with five viral coat-protein genes representing five very different viruses. These experiments could have immense effects on agricultural production in the United States within this decade.

*Material for this section was prepared by Clarence A. Ryan, Washington State University; R. James Cook, Agricultural Research Service, USDA; and Robert Haack and Leah Dauer, North Central USDA Forest Service Experiment Station.

Transforming Crop Plants for Defense Against Insects: Some insect pathogens suppress insect populations by producing potent, insect-specific toxins. These living microorganisms, or their products, offer many advantages over synthetic pesticides for insect control, including their specificity, safety to nontarget species, and suitability for modification by recombinant DNA techniques.

The insect pathogen *Bacillus thuringiensis* produces a crystalline protein that is highly toxic to insects. Variants of this bacterium and its toxin can kill more than 50 species of lepidopterous insects, including many that are serious crop pests. However, the toxin, like the microorganism that produces it, is unstable and is quickly inactivated when applied to the foliage of plants. Although advantageous in some respects, this feature also results in reduced efficacy of the toxin.

Monsanto scientists recently transferred the gene for toxin production from *B. thuringiensis* into tomato, cotton, and potato plants, thus giving these plants the ability to defend themselves against toxin-sensitive insect pests by producing the toxic protein in their leaves.

Insects that eat the plant tissues soon die. Protection afforded tomato plants by the toxin was even better in the field than preliminary greenhouse experiments had predicted. The many *B. thuringiensis* variants provide a broad spectrum of toxin genes useful for protecting specific plant tissues against specific insect pests.

Washington State University scientists have isolated several plant genes responsible for producing proteinase inhibitors. Proteinases are enzymes that insects and microorganisms use to digest plant proteins. Proteinase inhibitors are part of the chemical arsenal that plants employ to defend themselves. Some of the genes that produce proteinase inhibitors are activated by a hormone signal that is released from the wound site as insects feed. The inhibitors are rapidly transported throughout the plant. Recent evidence indicates that the presence of serine proteinase inhibitors in plant leaves can reduce leaf feeding by insects and leaf infections by microorganisms. Scientists can now cause plants to have high concentrations of inhibitor proteins in specific tissues. Specific inhibitor genes act against specific insects and pathogens; they can now be assessed for their potential usefulness in protecting crop plants against foliar-feeding pests. Proteinase-inhibitor genes from tomato, potato, and alfalfa plants are presently being inserted into crop plants to test their effectiveness in protecting the crops against insect pests. Because the inhibitors are not produced in the plants after harvest and residual inhibitors are inactivated upon cooking, these chemicals present no risk to people.

Molecular Characterization of Genes for Disease Resistance in Plants: A major effort is underway to determine the genetic basis for plants' early defensive reactions to potential bacterial and fungal pathogens. Scientists at the University of California made a major breakthrough recently by cloning the antithesis of a plant resistance gene—a gene for avirulence in a bacterial pathogen of soybeans. Since resistance and avirulence are controlled by a match-up between genes (gene products) in the plant and pathogen, the cloning of avirulence genes from the bacterium will help narrow the search for the corresponding resistance genes in the plant. Considering that plants have 100 to 1,000 times more DNA than the human genome, this is a significant accomplishment. When scientists perfect the techniques for engineering crop plants to express resistance genes

from unrelated or wild plants, disease control on a general scale will be possible. The genes for resistance to virtually every bacterial or fungal disease exist somewhere in the plant kingdom.

In addition to these specific resistance genes, scientists are using recombinant DNA technology to understand and manipulate so-called disease-response or disease-related genes. Expression of these genes, which usually occurs later in the disease process, causes the plants to synthesize antimicrobial chemicals and other defensive proteins and chemicals that temper disease severity.

Plant Defense by Plant-Microbe Associations: Plants support large communities of harmless microorganisms on their roots and leaves. Until recently, the only ones thought to be beneficial were those responsible for improved plant nutrition—the nitrogen-fixing bacteria and the mycorrhizal fungi responsible for more efficient uptake of phosphorus by roots. Plant-associated microbes are now recognized as an important means—in some cases the only means—of plant defense against infectious diseases and insect attack. The so-called "ice-minus" bacteria used to control the frost damage triggered in foliage by ice-nucleating active (INA) bacteria is perhaps the best known example. Field-testing the genetically manipulated INA bacteria began in 1988 in California on both potatoes and strawberries.

Plant-associated microbes are especially promising as delivery systems for gene products—natural pesticides—that inhibit plant pests. Such microorganisms function as a "third party" in plant-pest interactions. They are potentially useful vehicles for pest suppression techniques requiring the use of genes that cannot yet be integrated into the plant genome.

Root-colonizing bacteria, selected for ability to produce antibiotics, have exhibited a remarkable ability to protect plant roots against disease. They produce antibiotics in response to infections, thus suppressing further development of the disease. Using genetic manipulation to activate and inactivate the antibiotic-producing genes, Agricultural Research Service scientists at Washington State University have proven the relationship of the antibiotics to disease resistance in wheat. Field tests with naturally occurring strains are now in the fifth to sixth year for wheat in the Pacific Northwest, cotton in the Mississippi Delta, and potatoes in California. Two products, one for use on seeds and one for use in the soil, are now available commercially.

The bacterial pathogen *B. thuringiensis is* even more unstable in soil than on plant leaves. As a consequence, it has been of limited value for controlling root-attacking soil insects. Monsanto scientists have successfully transferred the *B. thuringiensis* toxin production gene into a strain of root-colonizing bacteria adapted to roots of corn. This strain, when established under controlled conditions around corn roots, has shown potential to protect the corn roots against certain soil insects.

Scientists at the University of Maryland have inserted the *B. thuringiensis* toxin gene into a stem-inhabiting nonpathogenic bacterium obtained from Bermuda grass. The strain is now being field-tested in cooperation with Agricultural Research Service scientists in Beltsville, Maryland. This strain has the potential to control insect pests that attack the stalk tissue of corn plants.

The *B. thuringiensis* toxin genes also have been incorporated into *Pseudomonas* bacteria using recombinant DNA technology, which synthesize the toxin. The toxin is stored even after the organism is heat-treated to kill it. The dead pseudomonads can then be applied to fields. In this protected form, the toxin can remain active for longer periods of time, thus increasing its potential for controlling pests that attack plants.

USDA's Higher Education Programs—A Decade of Progress*

Since the late 1800's, the U.S. Department of Agriculture has actively fulfilled its legislative mandate to advance agricultural science and technology transfer through national research, extension, and educational policies and programs. The achievements of the Agricultural Research Service, the Cooperative State Research Service, and the Extension Service have led to innumerable benefits to the American public and the world-at-large. Over the past 100 years, these USDA agencies have promulgated a unique partnership between the Federal Government, the States, and the private sector. This alliance devoted to the advancement of agriculture is unparalleled in any other part of the world.

The past century of U.S. agricultural progress can be attributed, in large measure, to the U.S. Department of Agriculture's role in providing national research, extension, and educational leadership characterized by strong linkages with the Nation's university system and the private sector. Recognizing the significance of this unique cooperative partnership and voicing strong concern over the diverse array of problems converging upon the Nation's college and university teaching programs in the food and agricultural sciences, the Congress enacted landmark legislation some 10 years ago designating the Department of Agriculture as the Federal Government's lead agency for higher education in the food and agricultural sciences. Specifically, the Food and Agriculture Act of 1977 (Public Law 95-113) charged the Department with strengthening the quality of the food and agricultural sciences higher education system and assuring the Nation of an adequate supply of food and agricultural scientific expertise. The 1981 and 1985 Acts reaffirmed these responsibilities.

America's food and agricultural system is one of its greatest success stories. Everyone uses the products of the U.S. science-based food and agricultural industry. The need for more cost-efficient production and the demand for agricultural products will grow in the years ahead as societal requirements for food and fiber increase and as production resources diminish. But these needs cannot be met without highly qualified scientists and professionals who are working to advance the frontiers of knowledge and technology. One of the most crucial variables in the food equation of the future is scientific and professional human capital.

Milestone Accomplishments in Higher Education Programs

In response to its Congressional mandate, the Department established the office of Higher Education Programs in 1978. This office has undertaken a broad array of national initiatives to strengthen the linkages between teaching, research, and extension programs in order to promote an integrated system for developing new knowledge and technology transfer. USDA's Higher Education Programs can point to many milestone accomplishments. The following are a few selected examples.

*Material for this section was prepared by K. Jane Coulter, Higher Education Programs, USDA. Mary Clutter, National Academy of Sciences, and Arnold E. Denton, Campbell Soup Company, reviewed the section.

Improving the Quality of Educational Programs:

• In 1984, the Secretary of Agriculture sponsored a National Challenge Forum on "Investing In Brain Power: Keeping U.S. Agriculture's Competitive Edge." The Forum, cosponsored by the National Academy of Sciences Board on Agriculture, brought together representatives from academia, industry, and government. They met to consider ways to stimulate private-sector initiatives for strengthening the university system primarily responsible for training the Nation's supply of food and agricultural scientific and professional human capital. The Challenge Forum led to the establishment of a national task force made up of industry, government, and university representatives. This body has recently engaged the American College Testing Program to undertake a national marketing research study to determine ways to enhance public awareness of the science of agriculture.

• An institutional strengthening grants program was initiated in 1985 for historically black land-grant institutions. The program was targeted toward improving the quality of curriculums, faculty, library resources, instructional equipment, and student recruitment at these unique institutions.

• USDA has provided national leadership in the design, management, and support of a number of national projects aimed at strengthening the quality of curriculums, faculty, and students. Conducted by university cooperators, the initial efforts have focused on a systems approach to agriculture and the food system, ethics and public policy, and international agribusiness marketing.

• The National Academy of Sciences (NAS) was commissioned to conduct a major study to determine competencies needed by future food and agricultural scientists and to develop recommendations for enhancing their graduate training. The NAS report, published in 1988, is currently the major frame of reference for rethinking graduate education.

• USDA and the Department of Education jointly sponsored a recently released National Academy of Sciences study addressing alternatives for enhancing the quality of agricultural education at the secondary school level. The study concentrates primarily on strategies and mechanisms for enriching both the business and science components of secondary agricultural education programs.

Improving Capabilities for Forecasting the Nation's Supply of, and Demand for, Food and Agricultural Scientific and Professional Expertise:

• USDA's office of Higher Education Programs has worked extensively with other Federal agencies (particularly the National Science Foundation, the Department of Labor, and the Department of Education) to improve the quality of national education and employment data acquisition and reporting.

• A national computerized information system known as the Food and Agricultural Sciences Education Information System (FAEIS) has been developed. FAEIS provides online access to a comprehensive array of current and historical data essential to higher education planning and evaluation—such as enrollments, degrees conferred, student support, placement of graduates, employment opportunities for graduates, and faculty information.

• The Office of Higher Education Programs produces a series of national publications documenting current and projected supply/demand statistics for baccalaureate and higher degree graduates in the food and agricultural sciences. Updated every 5 years, these are the only such publications ever made available to university administrators, faculty, students, and employment counselors. They have proven to be of extraordinary value in long-term strategic planning.

• USDA has supported the design, publication, and national dissemination of food and agricultural sciences project workbooks for high school science classes, "Attracting Academically Talented Young People Into Food and Agricultural Scientific and Professional Careers".

• A National Research Apprenticeship Program was established in 1979 to enable science-oriented high school youth to gain work experience in university or Federal laboratories. This program, which is strongly directed toward minority and female youth, has involved approximately 3,000 potential young scientists.

• In order to network more effectively with high school science classes, USDA has joined with industry to support the Council for Agricultural Science and Technology in preparing and disseminating a special publication entitled "Science of Food and Agriculture." This quarterly publication is designed to inform teachers and their students of the scientific underpinnings of America's vital food production and processing system and to increase student awareness of the outstanding career opportunities available in the food and agricultural sciences. It is distributed to 12,000 high school department heads registered with the National Science Teachers Association. In addition, many Colleges of Agriculture purchase complimentary subscriptions for high school science classes in their respective States.

• In 1984, the Department initiated a National Needs Graduate Fellowships Grants Program to stimulate the development of outstanding expertise in targeted shortage areas (biotechnology; bioprocessing or food/agricultural engineering; food, forest products or agribusiness marketing; water science; and food science/human nutrition). The average Graduate Record Examination score of fellows in the program is almost 1,300, more than 300 points higher than the average graduate student in agriculture. Thesis topics chosen by fellows include studies in molecular biology, plant biotechnology, animal diseases, water management, nutritional sciences, international marketing, and systems management. The quality of scientific expertise emanating from this program promises to be outstanding and strongly attests to the value of a cooperative partnership between the higher education system, the USDA, and the Congress.

• In 1987, USDA provided major leadership in helping the higher education community secure an industry sponsor for a "National Scholars Program." This program provides each competitively selected young scholar $6,000 annually for a period of 4 years to pursue a baccalaureate degree in agriculture or the life sciences.

Broadening the Public's Image of the Scientific Basis of the U.S. Food and Agricultural System:

• USDA has worked with its university cooperators to establish a national career infor-

mation center. Operating under the program name "Food and Agriculture Careers of Tomorrow" (FACT), the center prepares and disseminates popular career information publications, video tapes, news releases, and exhibits. FACT's first publication was entitled "Energize the Green Machine." This exciting publication addressing the broad spectrum of scientific and professional food and agricultural careers is being distributed to the public via the exhibit on "The Land" at Disney World's EPCOT Center.

• USDA has designated Ms. Susan Forte the national "Agriscience Ambassador." She is appearing at youth meetings across the Nation and on public media. Forte, who placed 13th in the national "Teachers in Space" competition, is receiving accolades from audiences all across the Nation.

The Department and its university cooperators have established a strong public-private partnership on behalf of food and agricultural sciences higher education. The past decade of progress not only affirms the value of the program to date, but also suggests unprecedented opportunities for the future.

Developing New and Improved Foods for Health and Convenience—Researchers, Producers, and Processors Are Keys*

American consumers are showing an increasing interest in nutrition and a lifestyle directed towards wellness. There is increasing awareness of potential relationships between diet, nutrition, and health. As a result, producers are being asked to provide the raw materials that processors can convert into foods with such characteristics as lower fat content, more polyunsaturated or monounsaturated fatty acids, more complex carbohydrates (dietary fiber), less cholesterol, and more omega-3 fatty acids. Continuing changes in lifestyles also have increased the demand for convenience in food preparation. These consumer demands are reflected in new foods or modified food products that are being produced as a result of cooperation between researchers, producers, and processors.

Dairy Foods: Milk and dairy products are important components of a healthy diet. They offer a good balance of proteins, fats, and carbohydrates and are a good source of essential nutrients such as calcium, amino acids, essential fatty acids, and required vitamins. To meet changing consumer desires, scientists are developing new technologies to produce low-calorie, altered-carbohydrate, reduced-fat, and low-sodium dairy foods. Freeze concentration, a technique for removing water from milk, yields a product with unique functional characteristics. The concentrate can be reconstituted, processed further, or combined with other food ingredients to develop new dairy products that taste better than those produced by previous processes. Removing cholesterol from milkfat, either by supercritical fluid extraction or by biotechnological techniques involving the use of microbes, may allow production of reduced-cholesterol milk, butter, cheese, and ice cream.

Ultrafiltration is being used commercially to concentrate milk for cheesemaking. Research has led to the commercial production of lactose-free dairy foods for consumers who cannot metabolize lactose. These foods include fluid milks, cottage cheese, proc-

*Material for this section was prepared by David R. Lineback, North Carolina State University; Dennis Heldman, National Food Processors Association; John Cherry, Agricultural Research Service-USDA; and Gary C. Smith, Texas A&M University.

essed cheese, and ice cream. Cheese manufacturers have been plagued by infections (phages) that destroy the bacteria in starter cultures and cause rapid failure of fermentation. Recent research advances in genetic manipulation have enabled the construction of phage-resistant starter cultures that are now being used commercially. New dairy technologies are leading to new foods that provide added value, variety, quality, convenience, and cost savings to the consumer.

Dietary Fiber: There is an increasing realization that consumption of dietary fiber (complex carbohydrates) is related to the health of the gastrointestinal system. One of the current dietary goals set by the National Cancer Institute is for U.S. citizens to increase their daily intake of fiber-rich foods. The Institute recommends the consumption of 20 to 30 grams of fiber per day for adults; the current daily average intake is only 10 to 15 grams. Dietary fiber is composed of several components, often characterized as soluble and insoluble, which have different physiological effects. Insoluble dietary fiber, such as bran, is effective in reducing constipation and in preventing and treating diverticulosis. Soluble dietary fibers, such as gums and pectins, reduce the concentration of cholesterol in the blood. Processors have developed new food products with increased dietary fiber content, both soluble and insoluble. Emphasis is being placed upon the increased production of grain products high in dietary fiber, such as oats, for use alone or for incorporation into other food products. The concentration of soluble fiber in oats is somewhat variety dependent, leading breeders and producers to seek new oat varieties with increased soluble fiber content.

Lean Beef: Consumers are becoming more conscious of the health benefits of reducing fat content in their diets. As a result, beef producers and processors have developed production and processing techniques that reduce the fat content of beef. Beef cattle marketed today are less fat than those of two decades ago, as a result of both breeding and feeding practices. The National Beef Retail Market Basket Study confirms a 27 percent reduction in total fat content of beef retail cuts between early 1986 and early 1988. Virtually all of the decrease was accomplished by physical removal (knife trimming) of external and seam fat. A study commissioned by the National Academy of Sciences determined that beef containing 3 percent to 7 percent intramuscular (marbling) fat would be acceptably flavorful, juicy, and tender and would meet diet, health, and nutrition constraints. The cattle industry is now using genetic techniques and production changes to produce cattle that are within this range of fat content. Producers, processors, and researchers are working together to produce beef that can be part of a heart-healthy diet for the American consumer.

Microbial Food Safety: Recent outbreaks of foodborne diseases—listeriosis, salmonellosis, and yersinosis, as well as enteritis from *Aeromonas* and *Campylobacter*—have generated great interest in developing rapid microbial detection methods and have spurred on the study of the mechanisms of virulence and control. Agricultural Research Service, university, and industrial scientists have made major contributions toward developing improved methods for detecting food poisoning organisms. Two new techniques, for example, are enabling researchers to study the transmission and virulence of organisms that can grow at refrigerator temperatures: (1) a purple dye test to pinpoint virulent strains of *Yersinia entercolitica* and (2) the development of highly selective media for isolation and quantitative detection of *Listeria monocytogenes* and *Aeromonas hydrophila*. Scientists are increasing their understanding of the influence of food composition and processing additives on

the virulence of *Staphyloccus aureus, Clostridium botulinum, Salmonella* and *Shigella* spp., and *Listeria monocytogenes,* particularly with regard to salt and nitrite levels, ionic compositions, and tissue binding. These new methods are enhancing the ability of industry and regulatory agencies to evaluate foods for the presence of these potential pathogens and to develop methods to control them. Producers, processors, and researchers are cooperating to furnish consumers with a high degree of safety in the food products available in the marketplace.

Cereal Grains and Grain Products: Cereal grains and their products are consumed at virtually every meal and are an important component of a healthy diet. Researchers have steadily increased their understanding of the role of the components of grains in cereal foods, such as those of wheat in bread and other baked products. For many years, wheat varieties were released to producers primarily on the basis of yield; baking quality characteristics were not necessarily considered. As a result of cooperation between researchers, millers, bakers, and wheat breeders, however, wheat varieties are now also evaluated for their milling and baking quality before being released commercially. Breeders seek to develop new varieties that not only offer disease resistance and high yield, but also incorporate excellent milling and baking characteristics. As a result, the industry can supply American consumers with more consistently high-quality baked products.

Aseptic Processing: The applications of aseptic processing technologies have accelerated over the past 5 to 10 years as a result of significant cooperation between university, government, and industrial researchers. The availability of new container materials stimulated research on sterilization of container surfaces that contact the product and on systems for filling convenient, flexible containers. Accomplishments have brought renewed attention to continuous processing systems for a variety of liquid foods and have resulted in the packaging of higher quality products in many different flexible container types. This technology has the potential to virtually revolutionize the industries that produce juice and related beverages.

Current research challenges include developing microbiologically safe thermal processes for low-acid liquid foods containing particulates and aseptic methods for filling these products into a variety of container types. Since these foods do not require refrigeration before opening, a new array of healthy, convenient, tasteful products is becoming increasingly available to the consumer.

Microwave Packaging: The availability of microwave ovens in the modern home, along with the consumer desire for convenience in food preparation, has created many new product and process development challenges. Research in university, government, and industry laboratories has contributed to the development of new technologies associated with microwave-ready foods. An important breakthrough in polymer chemistry has resulted in the development of a variety of containers that allow for heating foods in a microwave oven while maintaining desired levels of microbiological stability. Entirely new processing systems have been developed to ensure that products in microwave-ready containers have the same degree of shelf stability as those in rigid metal containers.

A new generation of containers will include those that provide differentiated heating of different food components within the same container. This type of heating is made possible by materials that collect the microwave energy and focus the heat within the container at the appropriate locations. These technologies are still evolving and contributions are continuing from all sectors.

Salt Reduction: In recent years there has been an increased desire for reducing the salt content in most American diets. In the normal U.S. diet, approximately one-third of the salt content is naturally present in the food, one-third is added during processing, and one-third is added by the individual. This offers great opportunity for the researcher and processor to cooperate in reducing the salt content in many foods. However, salt often plays a major role in controlling the microbiological safety of food products. By enabling a better understanding of the role of salt in food products, research conducted by university, Agricultural Research Service, and industry scientists has permitted the reduction of salt in many food products without compromising food safety. Salt has been reduced by as much as 40 percent in frankfurters and corned beef without adversely affecting the safety of the products.

Americans consume many fermented food products: pickles, olives, sauerkraut, yogurt, cheese, and other fermented dairy products. These are often relatively high in salt content as a result of both the fermentation procedure and the role salt plays in microbiological safety. Research into the fermentation of cucumbers into pickles, conducted by Agricultural Research Service and university scientists in cooperation with industry, has resulted in the development of a new fermentation system, which is being used experimentally by some pickle producers. It is a closed, anaerobic system with bulk tanks constructed from polyethylene or fiberglass. Because this system permits much greater control of the process, it promises improved product quality and the potential for reducing the salt content of the pickles. This cooperation between producer, processor, and researcher is resulting in improved fermented food products for the American consumer.

Recruiting Minority Students for the Agricultural Sciences*

Enrollment of Minority Students: Enrollment of minority students in Colleges of Agriculture and Natural Resources has historically been low. However, innovative recruitment and retention programs are significantly increasing the enrollment of minorities nationally, and results have been dramatic at some institutions. While overall national enrollment in agricultural sciences has declined consistently since 1979, minority enrollment has increased moderately and now stands at almost 5,000 students, representing 5 percent of undergraduates and 11 percent of graduate students in 1987.

Many reasons have been offered as explanation for low minority participation in agricultural sciences. The two major factors appear to be (1) a lack of awareness of the broad range of employment opportunities available to graduates and (2) limited opportunities for hands-on, state-of-the-art experiences in the agricultural sciences. A combination of individual State college and university programs, supported in part by Federal initiatives, has dramatically addressed these two limiting factors.

*Material for this section was prepared by Joseph E. Kunsman, University of Wyoming.

Career Information Programs: One such program is the Career Information and Apprenticeship Programs for Outstanding Minority Students. The Minority Apprenticeship Program at Michigan State University is structured to provide high school minority students with preprofessional hands-on experience in agriculture and natural resources careers. During the 7-week program each participant works directly with a professional from either the university, the State Department of Agriculture, or the State Department of Natural Resources. Each student works on a one-on-one basis in the professional environment of the supervisor. On two evenings each week, visiting corporate executives and governmental leaders present leadership seminars. These seminars expose the entire group of minority students to a broad array of career choices. Three day-long field trips also provide specific career information. When the program began in 1982, the enrollment of the College of Agriculture and Natural Resources consisted of only 5 percent minorities, well below the university level of 8.5 percent. By 1987 the College minority enrollment was 12 percent, exceeding that of the total university.

The University of Illinois College of Agriculture is working with Illinois high schools through the University's Principal's Scholars Program. Nearly 3,000 minority students are enrolled in this program, which provides career information to students from the freshman through the senior year. This career awareness is augmented with a 4-week on-campus summer enrichment program where agriculture college faculty and staff provide laboratory experience and career presentations. In addition, an innovative Agricultural Writing Competition offers statewide competition for minority high school students. Students write essays on issues raised in agricultural research publications that the College provides to the high schools.

Previously low minority enrollment (1.7 percent) at the University of Wisconsin College of Agricultural and Life Sciences prompted similar career information and enrichment programs. In addition, retention of minority students became an important issue. Course selection guidance, career advising, and personal counseling, it was found, increase the likelihood that students will graduate. The college appointed a Minority Program Coordinator to serve as the academic adviser for minority students, thus providing direct contact between the students and the academic system. As a result of this and other supporting programs, the College of Agricultural and Life Sciences minority enrollment now exceeds 6 percent.

By far the most extensive programs to increase minority enrollment in Agricultural and Natural Resources were developed at the University of California-Davis. These programs, first established in 1975, are directed toward junior high, high school, and college undergraduate students. Junior high school students are encouraged to take the necessary college preparatory courses. Capable students who may not have previously considered college as an option are encouraged to continue their education after high school. The high school program attracts students who are college-bound but not presently considering academic fields within the agricultural and environmental sciences. The undergraduate students are brought to campus to learn about graduate school opportunities in relevant scientific fields. This last group holds promise for rapidly enlarging the pool size of qualified candidates for graduate school and, subsequently, for faculty positions.

The junior high school program "Getting Ready for the Future" consists of a 3-week campus resident program of courses, research projects, and cultural events. Since 1976 approximately 20 percent of the participants in this program eventually attended the University. The program has since been modified to include 4 weeks of study at which qualified minority students can earn five units of high school credit.

An annual Agricultural Science Field Day attracts large numbers of minority high school students and faculty advisers. The program is conducted in association with the USDA's Summer Research Apprenticeship Program. High school juniors and seniors conduct research under the direction of a UC-Davis faculty member. To date, 54 percent of the participants in this program have subsequently enrolled at the University.

The program to encourage undergraduate students to consider graduate training in the agricultural and resource sciences is called the Summer Undergraduate Affirmative Research Program. Students who have completed at least 2 years of college-level education are invited to spend 8 weeks on the Davis campus, working with a faculty mentor on a research project of mutual interest. Students work 40 hours per week as integral members of a research team, participating in laboratory meetings and other lab-related activities. Each student receives a stipend, and all expenses are covered by the program. Since the program began in 1982, 41 percent of the participants have attended or are currently enrolled in graduate or professional programs.

In 1985 a position was created to work full-time with minority students to increase their retention rate. As a result of this effort and the other noted outreach programs, the College of Agricultural and Environmental Sciences at UC-Davis has increased its number of ethnic minorities by 62 percent. These minorities now make up 27 percent of college undergraduate enrollment. The increase is reflected in all ethnic minority groups represented, including American Indian, black, Chicano, Latino, Filipino, and Asian.

Strengthening Programs: Another highly successful effort is the 1890 Strengthening Grants Program. This program, established by Congress in 1985, has contributed significantly to the recruitment and enrollment of minorities in the agricultural sciences at 1890 land-grant institutions. Besides providing for full-time recruiters and scholarships for minorities, the funds are used for faculty development activities and curriculum restructuring to better address minority needs. Several notable cooperative efforts have been established by a number of universities under the aegis of the Strengthening Grants Program.

Southern University established an inter-campus program with the University of California system, and the University of Maryland-Eastern Shore cooperates with the State University system for faculty and curriculum development. Tuskegee, Lincoln, and North Carolina A&T universities regularly conduct summer workshops for outstanding science students. In addition, all 1890 institutions now conduct summer minority research apprenticeship programs for high school juniors and seniors in the upper one-third of their high school class. These programs provide agricultural research exposure for minority students and facilitate interaction between agricultural scientists and the students. The University of Maryland-Eastern Shore is one of the few universities presently providing meaningful

exposure to the agricultural sciences for gifted primary school students. Talented fifth and sixth graders are brought to campus and involved in ongoing agricultural science research projects.

Another program is the High School Research Apprenticeship Program. This program, part of a White House initiative begun in 1980, is designed to stimulate interest in science and engineering careers among racial and ethnic minorities. The Cooperative State Research Service and the Agricultural Research Service actively participate. The program establishes a working relationship between high school students and researchers at universities and USDA research facilities. The Cooperative State Research Service cooperates with more than 60 colleges and universities in the program each year. In many cases, State funds supplement Federal support.

To qualify for the apprenticeship program, participating high school juniors or seniors must rank in the upper 25 percent of their class, express an interest in science as a vocation, and be a member of a racial or ethnic minority. The students receive a small stipend which enables them to spend the summer engaged in meaningful food and agricultural research. Academic counseling, career information, and an orientation to research is also part of the summer experience. A recent evaluation reported that 85 percent of the summer apprentices have continued their education at colleges and universities and 20 percent are majoring in areas related to food and agricultural sciences.

The Agricultural Research Service (ARS) places its minority high school student recruits in regional research laboratories via Federal appointments. Since 1980, nearly 2,000 students have participated in this program. In addition, ARS has provided funding to Delaware State College and Southern University to support summer science enrichment programs for promising minority students. A similar program at Lincoln University, begun in 1981, has seen 80 percent of the subsequently enrolled students complete their degree and 50 percent enter graduate programs.

Future Outlook: Although substantial progress has been made in the recruitment of minorities into agricultural science higher education, efforts must continue. The University of California-Davis program will be used as a model for encouraging minority students to pursue advanced degrees in agricultural and natural resource science. This will help provide the much-needed pool of minority faculty to serve as effective role models for future generations. At the other end of the spectrum, projects aimed at the younger gifted minority student (5th to 10th grade) are necessary to intervene before career decisions and school curriculum selection are made. A variety of innovative programs have already been suggested, such as research work-study programs for undergraduate minorities; the establishment of a national center for training minorities in agricultural and biological sciences; and workshops, science fairs, and apprenticeships aimed specifically at gifted and talented minority students.

Revitalizing and Improving Agricultural Curriculums*

The National Agricultural and Natural Resources Curriculum Project began in 1982 in response to the critical need to improve curriculums in the Nation's colleges of agricul-

*Material for this section was prepared by Richard Merritt, Rutgers University; and Keith Wharton, University of Minnesota.

ture. Two national organizations—the National Higher Education Committee of the Joint Council on Food and Agricultural Sciences, and the Higher Education Programs office within USDA–were particularly concerned. In 1981, curriculum improvement was the highest priority of the National Higher Education Committee. Initial funding for the project was made available through the Higher Education Programs Office.

First, a task force was appointed to survey the current status of curriculums in the Nation's colleges of agriculture. Task force members represented the National Association of State Universities and Land-Grant Colleges (NASULGC), the American Association of State Colleges and Universities (AASCU), the Joint Council's National Higher Education Committee, USDA agencies, and business and industry. The task force held regional and national meetings, developed survey instruments, evaluated the results of the surveys, and recommended long- and short-term solutions to the problems identified. A significant result of this survey was the development of concepts and techniques for reviewing, assessing, and revising curricular programs.

The survey helped identify and rank 12 high-priority areas not adequately represented in the agricultural curriculums at that time: Systems Approaches to Food, Agriculture, and Natural Resource Problems; Ethical Aspects of Food, Agriculture, and Natural Resource Policy; Computers in Agriculture; Problem Solving; Cultural and Social Aspects of Domestic and International Agricultural Systems; Energy Use in Food and Agricultural Systems; Integrated Reproduction Management; Man and His Food—Biological and Consumer Aspects; Systems of Integrated Pest Management; Leadership Development; Internships and Cooperative Education; and Student Projects.

The task force recommended that certain of these high-priority areas be developed into courses or course modules, that concepts and techniques be developed for curriculum revitalization, and that support for development come not only from the universities, but also from external sources such as foundations, business, industry, and government.

Starting in 1983, two national and international teams composed of faculty and business representatives worked for three years to develop course and curriculum materials for the two highest priority areas: Systems Approaches to Food, Agriculture, and Natural Resources; and Ethical Aspects of Food, Agriculture, and Natural Resource Policies. The resulting materials are appropriate for new courses or modules at the undergraduate and graduate levels, and also form the basis for analyzing and suggesting strategies for curriculum change.

The curriculum for Systems Approaches to Food, Agriculture, and Natural Resource Problems was developed by a 7-member faculty team coordinated by Dr. Kathleen Wilson of the University of Hawaii. The team prepared a workbook, case studies, syllabuses, teacher's guide, three computer software packages, and other teaching materials. Two books will be published by John Wiley and Sons for distribution in fall 1988.

The curriculum and workshop materials for Ethical Aspects of Food, Agriculture, and Natural Resource Policy were developed by a 15-member faculty-business team coordinated by Dr. Robert Matthews of Rutgers University and Dr. Thomas Ruehr of California Polytechnic University, San Luis Obispo. A book containing curriculum materials developed for a series of workshops will be published by John Wiley and Sons.

Curriculum materials have been distributed to universities throughout the United States. In addition, many workshops, seminars, and symposia have been provided to professional societies, international organizations, and other such groups. Curriculum development continues on the other high-priority areas as personnel and funding levels permit.

The National Curriculum Project exemplifies the cooperative activities necessary to provide high-quality food and agricultural sciences training that will ensure that the Nation can successfully address future problems and identify and take advantage of opportunities. Curriculums must be continuously assessed and improved if the United States is to maintain a viable and prosperous agriculture.

Cooperative Extension System—Developing and Implementing Initiatives*

In 1985, the Extension Service-USDA and the National Association of State Universities and Land-Grant Colleges (NASULGC) Division of Agriculture's Extension Committee on Organization and Policy (ECOP) recognized the need to reaffirm the Cooperative Extension System's commitment and readiness to act on issues important to the Nation. This awareness was heightened by such events as the farm financial crisis in the early 1980's when the Extension system provided vital educational programming to financially stressed farm families.

The recognition of need led to the formation of a National Priorities Policy Task Force, jointly appointed by ECOP and ES-USDA in March 1986. Members met in June to establish the rationale, process, and format for establishing national Extension priorities. Eight priority issues were identified and a ninth has recently been added:

- Alternative Agricultural Opportunities
- Building Human Capital
- Competitiveness and Profitability of American Agriculture
- Conservation and Management of Natural Resources
- Family and Economic Well-Being
- Improving Nutrition, Diet, and Health
- Revitalizing Rural America
- Water Quality
- Youth at Risk

The Committee developed a report for review by ECOP, which then refined the priorities and directed that they be developed into national initiatives. Through these national initiatives, the Cooperative Extension System has focused its resources on issues critical to the economic, social, and environmental progress of Americans; issues that Extension and the land-grant university system have resources to address. The process is moving Extension into a more proactive role for the coming decade and beyond.

*Material for this section was prepared by Denzil Clegg, Extension Service-USDA; and Chester Black, North Carolina State University.

The initiatives are evidence of Extension's commitment to relevance and change and to being a vital force serving the needs of agriculture and the Nation's people and communities. The national initiatives enable Extension to strengthen its linkages with external groups—public and private—around common concerns and agendas. These coalitions focus combined resources on societal problems in ways that best use Extension's unique strengths in informal education and grassroots interaction. Such coalitions make more effective use of available resources and avoid duplication of effort.

The national initiatives process has been built on the concepts of strategic planning followed by issue-based programming. Strategic planning establishes mechanisms and procedures for identifying emerging issues. This planning incorporates a futuring panel, environmental scanning, and input and feedback from across the Cooperative Extension System and its stakeholders. A Strategic Planning Committee is the key decisionmaking body for identifying emerging issues that Extension should address. The Committee recommends the development of the highest priority issues into national initiatives. As a result of this process, Youth at Risk has recently been selected for addition to the national initiatives.

Issues programming, which places educational emphasis on matters of wide public concern through an integrated multidisciplinary approach, is being used to implement the national initiatives. Resources are organized and allocated to address issues which, in turn, determine the audiences that are served. Issues programming draws upon established strengths of Extension and reaffirms the successful and effective approaches that have taken place at the grassroots level since Extension's establishment.

Much of the success and acceptance of the national initiatives as a means to identify high-priority Extension missions can be attributed to the openness of the process. Thanks to the efforts of the National Initiatives Coordinating Committee, interaction has taken place continuously at all levels within the system and across a broad spectrum of society. Development proceeded through 1987 with the involvement and support of the entire Cooperative Extension System, including feedback from county agent associations, commodity groups, and other external groups. Task forces consisting primarily of representatives from State Cooperative Extension Services developed each initiative. Each task force identified critical issues, established linkages with commodity groups and other support groups, developed "white papers,"and identified model programs. Information on the initiatives was distributed through newsletters, fact sheets, "white papers,"and other reports.

The national initiatives were presented to the Cooperative Extension System, commodity groups and other external support groups, congressional representatives, and the Joint Council in January 1988. A national workshop for each initiative acquainted Extension specialists, agents, department heads, and others with content and strategies for implementation. As a followup, multidisciplinary national initiative teams have been established within the Extension Service-USDA to work with State and local counterparts in the implementation of the initiatives.

The national initiatives have reaffirmed the commitment of the Cooperative Extension System to meeting societal needs through educational programs. They have mobilized

the thinking of the more than 15,000 professional and support staff and hundreds of thousands of volunteers and support groups who make the System work. They offer the promise and potential for maintaining and enhancing Extension's role as a vital educational force into the 21st century.

Accomplishments resulting from cooperative activities entail some combination of States, agencies, institutions, businesses, and disciplines working cooperatively to address problems and opportunities that have impacts upon the food and agricultural science and education system. More and more emphasis is being given to interdisciplinary and inter-university efforts to solve problems which affect multi-State or multi-region areas. Many of the activities involve international cooperation as well.

Implementing Improved Curriculums To Meet Tomorrow's Needs

Meeting the Challenges of Veterinary Medicine:"Veterinarians for Society in the 21st Century"was the title of the Ninth Symposium on Veterinary Medical Education. This significant symposium, held in Davis, California, marked the first time that a national forum had brought together representatives of the veterinary colleges and other leaders in the veterinary profession to openly discuss concerns and to plan for the future.

Participants represented State associations, State licensing boards, regulatory agencies, industry, consumers, the American Veterinary Medical Association (AVMA), the Council on Education, the National Board Examination Committee, the Association of American Veterinary Medical Colleges (AAVMC), and the veterinary colleges (administrators, faculty, and students).

The impetus for the symposium was a growing awareness throughout the profession that the veterinary curriculum was becoming increasingly incompatible with societal needs for veterinary medical services in the 21st century. Changes in veterinary medical education and student selection criteria have not kept pace with the changes in agriculture, the profession itself, biomedical technology, specialization, educational costs, and manpower studies. Too many graduates are entering already crowded areas of the profession while severe shortages are predicted in others.

Almost 300 symposium participants probed, discussed, and explored solutions to the challenging issues facing veterinary medicine. Their specific recommendations are now being used at meetings of the many constituent groups. The veterinary medical colleges are addressing the issues and implementing changes within their institutions. For the first time, the profession has a framework for ongoing communications and dialogue aimed at meeting present and future challenges.

Agricultural Sciences Curriculums:"Curriculum Innovation for 2005–A Revitalization"was a project designed to establish and encourage curriculum change in the agricultural sciences. The project was a cooperative agreement between the USDA Higher Education Programs office and the North Central Regional Curriculum Committee. The objective was

to clearly and concisely identify concepts and philosophical issues which should be incorporated as basic elements in innovative curriculum models for the year 2005 and beyond.

A series of group discussions covering topics associated with curriculums for the future were held at several sites. These discussions and subsequent reports resulted in the printing and distribution of a new North Central Curriculum Committee Project publication entitled "Curriculum Innovation for 2005." Subsequently, a national conference on curriculum revitalization was held and the proceedings were published for national distribution. Issues addressed were: the necessity for curriculum innovation; the future of agribusiness in the year 2005; obstacles to achieving curriculum change; alternative educational delivery systems for the future; and the internationalization of the agriculture curriculum.

Speeding the Transfer of Technology

The Agricultural Research Service (ARS) has implemented 40 cooperative research and development agreements with industry since the passage of the Federal Technology Transfer Act of 1986 (P.L. 99-502) and the President's Executive Order 12591,"Facilitating Access to Science and Technology." The act gives Federal agencies authority to accept virtually any kind of assistance (including personnel, facilities, materials, and financing) needed to undertake cooperative research and development. This includes the reciprocal opportunity for Federal agencies to furnish the same assistance except financing.

Both P.L. 99-502 and E.O. 12591 seek to facilitate improved technology transfer through more liberal patent-licensing procedures. Cooperative research and development agreements are authorized, which may include the exclusive licensing of inventions to the private cooperator. This makes such cooperative agreements more attractive to private cooperators by permitting the Federal agency to negotiate patent-licensing agreements during the initiation of cooperative endeavors. The ultimate objective of the act and the executive order is to ensure that technology can be put into commercial application promptly. The benefits of ARS-university cooperation are well established; now similar benefits can be realized from ARS-industry cooperation, and the door is open for three-way (ARS-university-industry) cooperative research and development arrangements.

Competitiveness Enhanced Through Research and Development Consortium

Biotechnology affords promising new opportunities for innovation in the processing of agricultural commodities and development of new and expanded uses for them. Exploiting these opportunities is the objective of a new cooperative program, formally announced in March 1988, involving the ARS Northern Regional Research Center (NRRC), the University of Illinois Biotechnology Center (UIBC), and Biotechnology Research and Development Cooperation (BRDC). The six companies participating in BRDC are American Cyanamid, Amoco, Dow, Ecogen, Hewlett-Packard, and IMC. They are helping to fund research by scientists at UIBC and NRRC.

In addition to the financial support, which is supplemented by State and Federal funds, UIBC and NRRC get the benefit of the commercial technological insight of the industrial partners. For the companies, the consortium provides an early look at cutting-edge research results and options for exclusive rights to develop new technologies from scientific breakthroughs resulting from the cooperative research.

The consortium was formed under authorizations in the Federal Technology Transfer Act of 1986 and the President's Executive Order 12591 of April 10, 1987, "Facilitating Access to Science and Technology." The new consortium is a model for other future Federal laboratory-university-industry arrangements for cooperative research and development. If it is valid to extrapolate the Japanese experience to the United States, the ultimate result should be to improve the economic competitiveness of American agriculture.

Interactive Video Extension Network

Extension's interactive video network (IVEN) is using video discs to provide cost-effective delivery of educational programs to expanded audiences. This "cutting edge" technology uses microcomputers and videodisc players to present specific information to users. It allows them to select information of greatest interest and to interact with questions and feedback during the sessions. This approach extends the outreach of Extension specialists and permits the delivery of expert information to remote locations.

The IVEN network was founded in 1985 with participation from 30 States. The educational sessions include such programs as cash flow planning in Nebraska, home gardening and pesticide applicator training in Virginia, insect identification in North Carolina, home maintenance in Michigan, and State slide collection in Minnesota. Evaluation of the Nebraska program indicates that users have been able to develop realistic cash flow plans that improved their ability to work with financial institutions. Additional programs on other financial subjects are being developed in that State.

Innovative delivery of information within the IVEN network is being accomplished through the use of public service kiosks. These portable cabinets house the microcomputers, videodisc players, and display screens. The controls are readily accessible to users. The kiosks, located in county Extension offices, libraries, nurseries, agricultural supply stores, and shopping malls, make information available to users at their point of need. The interactive feature enables the user to select quickly the specific information that he or she needs. Kiosks have been demonstrated nationally and are being located in shopping areas in Virginia and in other States.

Rural Information Center

The national Rural Information Center (RIC) at the National Agricultural Library (NAL) was established to provide information and referral services to policymakers and others interested in rural America. It is a joint project of the NAL and the Extension Service (ES). The center combines the technical subject-matter expertise of Extension's nationwide educational network with the information specialists and resources of the world's foremost agricultural library. The RIC is designed to eventually link State and county extension offices throughout the Nation with rural community libraries, State land-grant university libraries, and the NAL.

The basic purpose of the RIC and its network is to provide the best available information to local, State, and national officials who implement programs for rural development and revitalization. It is a mechanism for accumulating and disseminating information about economic and social policies, resource use, revitalization, alternative income opportunities, community and public services, development of human capital, and other issues that affect rural America. The information includes not only results of current research, but also case studies and examples of successful economic development programs and contact people for those programs.

The information and services available through RIC are easily accessible to local government or rural community officials, educators, librarians, extension specialists, and all rural citizens through Extension's network of county and State offices, by mail or telephone, via electronic mail through the Dialcom network, and on NAL's electronic bulletin board. The NAL uses advanced technologies and, to the greatest extent possible, is promoting the use of such technologies throughout the agricultural information network. Regularly scheduled outreach programs, such as meetings, exhibits, and demonstrations of new technology, are a part of the Center's activities.

A RIC pilot program was implemented in January 1988 in six states: Georgia, Illinois, Iowa, Missouri, New Mexico, and Vermont. The Extension Service designates a coordinator in each participating State to work with NAL's RIC staff. By the end of fiscal year 1988, 35 States had joined the network.

RIC services include customized information products developed in response to specific inquiries, including requests for assistance in economic revitalization and local government planning projects; and information about funding sources, educational workshops, research studies, and other related issues relevant to maintaining the quality of rural life. Cited publications can be obtained through interlibrary loan. RIC refers users to organizations or experts in the field who can provide additional information and is developing a series of publications with special information summaries and literature citations on specific topics.

This cooperation between USDA agencies and State and local governments, communities, and institutions is creating a network for delivering information in a timely, practical, and thorough manner to potential users at all levels. Requests and inquiries from Congress, USDA, other Federal agencies, State and county officials, ES staff, universities, and rural organizations indicate that the network is making needed and significant contributions to bettering rural America.

RIC has identified several projects for the future: a monitoring and analysis system that will collect and summarize telephone-requested data to help determine future rural issues and information needs; a network of rural libraries, with RIC as its nucleus, supported by State rural library coordinators; a national expert panel of Extension specialists to develop "Future Trends" material; and an Extension consultant for public officials who need additional subject-matter consultation on particular subjects.

Computer/Telecommunication Link Speeds ARS Research Results to Extension

Because of the time involved in the publishing process, research results produced by Agricultural Research Service (ARS) scientists were not reaching State Extension specialists until many months after the research was completed. To overcome this problem, ARS, the USDA Extension Service, and the Cooperative Extension Services (CES) in Missouri, North Dakota, South Carolina, and Pennsylvania began in 1984 to establish and field-test a computer/telecommunications link. Research from other USDA research agencies, such as the Economic Research Service and Forest Service, also could be more rapidly transmitted to Extension using this system.

The computer/telecommunications link consists of the ARS (TEKTRAN) computer database and Extension's Cooperative Systems Information Network (CSIN) telecommunications capabilities. Each month, 100 to 125 one-page reports of new, unpublished

research results from ARS are downloaded from TEKTRAN to CSIN's Research Results Database (RRDB). The database can be accessed by Extension personnel at land-grant universities and also by interested professionals at many other universities.

In fiscal year 1987, 35 State Extension Services used this system to make more than 10,000 keyword searches for new research results, primarily from ARS. (A number of ERS research reports are now included on RRDB). Some State Extension Services provide copies of the research reports to their State Experiment Station counterparts. Further distribution is made in a few States by downloading the database into the State Extension Service's central computer system, which can be accessed by county agents and personnel at other outlying locations.

The TEKTRAN - CSIN link has greatly increased the availability and improved the timeliness of ARS research results for use by Extension specialists. A less pronounced, but very significant, advantage is the increased direct contact between ARS researchers and Cooperative Extension Service specialists.

Developing New Agricultural Alternatives

Cornell University faculty and Cooperative Extension staff are cooperating in a project that explores options for innovative agricultural enterprise development. The project provides information on starting new rural enterprises, diversifying existing farm operations, and developing new products, markets, or production practices that enhance producer profitability. Information bases that have been developed on these alternatives include specific opportunities and the problems that are associated with each of them. Four regional outreach events were conducted during the past year and training materials have been made available to Extension staff throughout the State.

The project has been implemented to serve farm and rural families. A survey conducted during the past year indicates that approximately one-fourth of New York State farm families were considering adding or changing enterprises in the near future. This Extension program and others are intended to meet the informational needs associated with these changes. They enable participants to become more sensitive to market potentials and to exploit the competitive advantage of their proximity to the Northeast's large metropolitan markets.

Faster Information Transfer From Researcher to User

New technologies that manage the retrieval, delivery, and storage of information have allowed librarians and library users faster, more sophisticated and cost-effective access to information. Rapid access to information is crucial to scientific research. The National Agricultural Library (NAL) staff conducted site visits to five major Agricultural Research Service (ARS) libraries (Eastern, Northern, Southern, and Western Regional Research Centers and the Russell Research Center). The interagency review identified an action agenda leading to an ARS library of the future which is state-of-the-art, cost-effective, and fully networked with the resources of the total agricultural information community, including land-grant university libraries.

The 40 recommendations address several broad initiatives, including: building long-term electronic linkages and gateway systems to information resources; acquiring more compact, machine-readable materials, such as CD-ROM, which offer enhanced access to information; reducing duplicative processing of materials; increasing resource-sharing; and

supporting end-user technologies that permit scientists to conduct library research from their office computers.

As a result of a 2-day library operations review workshop in Beltsville, Maryland, NAL will connect the five ARS libraries to NAL's integrated library system in a test mode. The system's sophisticated networking capabilities potentially can offer scientists online access to NAL's catalog and to its database, AGRICOLA, at a lower cost. NAL also will establish (with funding support from ARS) an ARS coordinator position at NAL to facilitate the transfer of information to ARS users and to ensure the closer working relationships which will be essential to the success of future joint efforts. This project is only one aspect of the ongoing dialogue between the two agencies. ARS and NAL management meet regularly to exchange ideas, discuss initiatives, and further identify areas in which NAL can strengthen its services to researchers and librarians, particularly in relation to the role technology can play in expediting and enhancing access to information.

Cooperation Between Educational Institutions Improves Educational Programs

A formal agreement has been signed between the University of Florida (UF) College of Agriculture and Pensacola Junior College (PJC). If the junior college provides a scholarship to a high school recruit who intends to study a field of agriculture, then UF will continue the scholarship when the student transfers to its College of Agriculture to complete work toward a bachelor's degree. The scholarship continues as long as the student is making satisfactory academic progress on a degree program in the College. This agreement is beneficial to both parties. The junior college can attract top-quality students by offering 4-year, rather than 2-year, scholarships. The College of Agriculture relinquishes its independence in selecting some of its scholarship recipients, but gains the recruiting effort of PJC.

A similar cooperative agreement has been finalized for transfer of students from the Agriculture Department of State Fair Junior College to the Agriculture Department of Central Missouri State University. This agreement lists transfer arrangements course by course.

The agricultural engineering departments at Washington State University and the University of Idaho (approximately 10 miles apart) are cooperating to eliminate low-enrollment courses and to maintain the array of courses required for viable degree programs in Agricultural Engineering (AgE) and Agricultural Mechanization (AgM). Each school maintains separate AgE and AgM degree programs; they cooperatively or jointly list a total of 29 AgE and AgM courses. As a result, the number of available courses has been expanded by adding a total of six AgE and six AgM courses taught at Washington State University. In addition, the universities rotate teaching responsibilities for seven courses.

International Cooperation—Solving Common Problems

Control of Asian Honeybee Mite: The Asian honeybee mite, a parasite which causes one of the most serious known honeybee diseases, threatens the $130 million U.S. honey crop and the pollination of many other agricultural crops. The mite, which several years ago brought European beekeeping to a standstill, was discovered in the United States in 1987.

Results from a recently completed Office of International Cooperation and Development (OICD) long-term collaborative research project involving scientists from Cornell University and Brazil have increased understanding of the biology of the mite and how to control it. Cornell researchers also discovered that African honeybees are highly resistant to attacks by

the mite. To avoid dependence on chemical control of the mite, these scientists are studying ways to combine the best qualities of several races of honeybees to produce a bee that is a good honey gatherer and pollinator and, at the same time, mite resistant.

Research on Maintaining Post-Harvest Quality: Maintaining quality in harvested fruits and vegetables until they reach the consumer is a major research concern of the U.S.-Israel Binational Agricultural Research and Development Fund (BARD). A good portion of BARD's ongoing postharvest research deals with finding nonchemical or low-chemical means of preserving fresh produce in storage. Examples of such efforts include: curing apple and citrus wounds that allow easy entrance to pathogens; heat and radiation treatments to surface-sterilize fruits; discovering natural products that control and monitor storage insects; or using natural compounds to control ripening and decay.

Many U.S. institutions are actively cooperating with Israeli institutions: Rutgers University; USDA/ARS at Winter Haven, Florida; Cornell University; the University of California at Davis and Riverside; and USDA/ARS at Fresno, California.

Insect Control: Another OICD cooperative combines the Netherlands and France with Agricultural Research Service and University of Georgia scientists in an interdisciplinary research program concerning the biological control of pests. They are investigating effective and environmentally safe pest management technologies by studying the foraging behavior of beneficial insects. The primary objective is to facilitate greater understanding of beneficial insects, such as certain parasites, as alternatives to the chemical control of pests. The discovery of a natural parasite to the corn earworm, for example, is expected not only to significantly reduce the more than $1 billion in annual damages which these pests cause on corn, cotton, soybeans, and certain vegetables, but also to minimize the cost of control and avoid adverse environmental impacts.

These current accomplishments represent a sampling of the thousands that have occurred during the past year. The National Committees (Agricultural Research, Extension, and Higher Education) of the Joint Council review the hundreds that are submitted for consideration and then forward their selections to the Joint Council. The Joint Council members review the accomplishment nominations and, through a ballot process, collectively select those for inclusion in this report. This year, the current accomplishments are presented by functional category rather than by program category.

Agricultural Research Accomplishments

Controlled-Release Pesticides May Reduce Groundwater Contamination: The public is becoming increasingly concerned about how agricultural chemicals, such as pesticides, may be endangering the quality of groundwater. To address this potential problem, researchers at the Agricultural Research Service have developed controlled-release pesticides to reduce the peak concentration of pesticides in cropland soils, thereby decreasing the possibility that they will significantly threaten groundwater quality.

Scientists cooked cornstarch in a jet of steam to create gelatin-like particles. Then they added a herbicide to this cooked cornstarch and stirred and dried the mixture. This caused it to crumble into granules, leaving the pesticide trapped in a microscopic honeycomb-like structure.

When applied to the field, this structure tends to release the pesticide slowly into the soil. This slow release lowers the maximum pesticide concentration in the soil. It also increases the time period during which the pesticide concentration is maintained at a level that exceeds the threshold needed for effective pest control.

Preliminary results show that these starch-encapsulated herbicides not only decrease the possibility of groundwater contamination, but also seem to control weeds as well as or better than pesticides applied in conventional formulations.

Genetically Engineered Bacteria Degrade Toxic Chemicals: Scientists at the University of California at Riverside have patented a new process to genetically engineer recombinant bacteria capable of cleaning up chemical waste. The process has the potential to create microorganisms that can degrade toxic polychlorinated biphenyls (PCB's), a major health and environmental hazard. Toxic waste sites could be cleaned up quickly and inexpensively.

The Environmental Protection Agency estimates it will take decades and cost more than $90 billion to clean up cancer-causing PCB's and other toxic chemicals in the Nation's worst dump sites. If the recombinant bacteria engineered at UC-R can be scaled up to commercial production, cleanup could be accomplished in a relatively short period of time at relatively low costs. The scientists have not manually spliced and inserted genes, but have invented an apparatus to take advantage of the natural genetic engineering which has been in existence for millions of years among bacterial species.

New Class of Nonchlorinated Pesticide: Recent research in the Pesticide Chemistry and Toxicology Laboratory of the University of California at Berkeley could result in safer, more effective chemicals for pest control, greater food safety, and reduced food and fiber costs. Studies on bicyclic compounds recently culminated in the discovery of a totally new class of very simple and effective insecticides. Although they disrupt the organism in the same way as toxaphene, dieldrin, lindane, and many other chlorinated insecticides, the new compounds contain no chlorine, so they break down into nontoxic substances more quickly.

The Berkeley researchers also have made important advances in developing synthetic substitutes for insecticides derived from natural materials. Earlier products of this type were synthetic pyrethroids, which duplicate the action of pyrethrins from chrysanthemum flowers, and methylcarbamates, which are a substitute for physostigmine from calabar beans. Recent findings provide strong evidence that two types of insecticidal alkaloids, the isobutylamides and ryanoids, are good models for future insecticides. Ryanodine, a natural insecticide prepared by grinding stems of the shrub *Ryania speciosa*, was synthesized in radioactive form so that researchers could localize and characterize its binding site in the

insect. They found that the binding site in insects differs from that in mammals, and that a much simpler compound, ryanodol, is selectively toxic to insects with little or no toxicity to mammals.

Fundamental knowledge about chemical-organismal interactions at the molecular level is helping researchers design new pesticides and evaluate the risks and benefits of established control procedures. This could alleviate pest resistance problems and provide more economical pest control.

Study Measures Impacts of Trade Intervention Policies: Economic Research Service (ERS) economists continued a major study to measure levels of government intervention in major trading countries and major commodity markets.

ERS published producer and consumer subsidy equivalents for 1982-84, showing the extent to which agriculture is subsidized and providing a key data base for policy officials, researchers, and others studying the effects of alternative trade liberalization policies and General Agreements on Trade and Tariffs (GATT) proposals. Results indicate the importance of reaching beyond border measures (tariffs, quotas, levies, etc.) in the next round of multilateral trade negotiations. Furthermore, the study reveals the need to focus on the relatively important role of domestic agricultural policies as distorters of world agricultural markets.

Other analyses by ERS economists highlight the differing levels of government intervention among developing countries, with intervention rising as the level of economic development improves.

Cotton Computer System Goes to the Farm: Use of the GOSSYM-COMAX expert computer system described in last year's report has more than doubled to about 150 grower cooperators in Mississippi and other cotton-producing States. It has reduced cotton production costs by $78 to $135 per acre. The expert system is the result of the efforts of a team of State and USDA-ARS scientists at the Mississippi Agricultural and Forestry Experiment Station at Mississippi State University and Clemson University.

This model was developed after approximately 15 years of research with contributions from 11 scientists representing four institutions in two countries. The program now in use combines the expert system (COMAX) with GOSSYM, the cotton model that simulates growth and development of the entire plant on an organ-by-organ basis (roots, stems, leaves, squares, blooms, and bolls). This technology will reduce the unit cost of cotton production and increase profitability for farmers and agribusiness. The main contribution will be more knowledgeable decisions in cotton crop management, including economic and environmental constraints.

Although the model was first envisioned as a research tool, scientists soon realized its potential in integrated cotton crop management. Pilot testing of the system has been underway for 4 years, culminating in last year's successful beltwide on-farm application in management decisionmaking. The research team received the Cotton Foundation MOBAY Research Award in January 1988 in recognition of the development of GOSSYM-COMAX.

Food Survey Results Reveal Dietary Changes: Food consumption research conducted by the Human Nutrition Information Service in 1985-86 indicates that Americans are changing their diet. On the whole, Americans have consumed less meat, eggs, and whole milk and more low-fat milk, grain products, and soft drinks since the last decennial Nationwide Food Consumption Survey in 1977-78.

Other results show that nutrient intakes for women in 1985-86 were as high as or higher than they were in 1977. However, average intakes for some nutrients continue to be below the 1980 Recommended Dietary Allowances. These include folacin, vitamin B6, calcium, iron, magnesium, and zinc. Thirty-seven percent of calories come from fat, below the 40 percent or more in earlier surveys. Mean intake of cholesterol for women was 280mg.

This information is compiled from the 1985-86 Continuing Survey of Food Intakes by Individuals, conducted by the Human Nutrition Information Service. The survey collected dietary intake data from a nationwide sample of women 19 to 50 years of age and their young children, ages 1 to 5, for 6 days ranging throughout a year. The Continuing Survey is designed to help assess the dietary status of the U.S. population between the larger decennial Nationwide Food Consumption Surveys. Six of nine planned reports have been published, presenting evidence of dietary changes since the 1977-78 Nationwide Food Consumption Survey.

Data collection for the 1987 Nationwide Food Consumption Survey began in spring 1987. This survey collects food consumption and cost data from private households, as well as 3-day food intake data from individuals residing in the households. Results will be available in late 1988. After data collection is completed for this survey, the Continuing Survey will be reinstated in 1989-96 to provide continuous information on the food and nutrient consumption of the American population.

Conservation Tillage Systems Increase Yields, Reduce Risk: In the semiarid conditions of the central Great Plains, managers can reduce risk and variability in income by utilizing conservation tillage for wheat and grain sorghum instead of traditional conventional tillage in a wheat-fallow cropping sequence. Kansas researchers found that yields were higher and variability was generally lower in the conservation tillage systems than in conventional tillage systems. As a result, net returns could be $12,000 to $22,000 higher per farm and variation in net returns could be reduced by as much as $3,000. This difference in risk is attributed to the soil moisture conservation characteristics of the conservation tillage system for wheat and sorghum in the central Great Plains.

Synthetic Pheromones Effectively Reduce Pine Tip Moth Populations: Controlling major forest insect pests by spraying toxic chemicals can be expensive and also hazardous to the environment. During the past decade, scientists have found a less expensive, safer way to lessen the reproductive success of many insects by confusing them in their search for mates. Forest Service research on the ponderosa pine tip moth, a significant defoliator of conifers in the West, has capitalized on breakthroughs in understanding how male and female insects find each other.

Like many insects (and some mammals), male ponderosa pine tip moths locate females by the scent (pheromone) they exude when they are ready to mate. Every insect species has a unique pheromone, and chemically analyzing and synthesizing them can be difficult. But researchers at the Forest Service's Pacific Northwest Station have synthesized the tip-moth pheromone. When this substance is applied to traps hung in trees, male tip moths are attracted to the traps instead of nearby females, whose scent signal is weaker.

In one test area, larval populations were reduced as much as 83 percent compared with normal ponderosa pine plantations. Shoot damage to young pines was reduced proportionately. This control method, which can be adapted to many other insects, is target-specific and environmentally safe.

Growth Hormone Produces Leaner Pigs: Researchers at the Pennsylvania, Georgia, Illinois, and New York Agricultural Experiment Stations have found that treating pigs with a naturally occurring protein hormone called porcine growth hormone (pGH) increases growth rate, improves feed efficiency, and alters carcass composition so pigs have more muscle and less fat. Researchers also discovered that recombinantly derived pGH mimics the biological effects of naturally occurring pGH. This finding represents a viable way to increase producer profitability while offering a leaner product (up to 70 percent less carcass fat) to consumers concerned about the relationship between heart disease and saturated animal fat consumption. Savings in feed costs alone in the United States could amount to $2 billion per year.

New Brucellosis Vaccine Shows Promising Results: A nine-member research team at the Texas Agricultural Experiment Station has completed initial testing of a new vaccine that could cause brucellosis to fade to a footnote. Brucellosis (Bang's disease) leads to spontaneous abortion, weak calves, decreased milk production, infertility in cows, and sterility in bulls.

The experimental "killed Brucella" vaccine (patent pending) is as effective as the USDA strain 19 "live" vaccine, without its drawbacks. The new vaccine does not cause false-positive test results and cannot infect humans, as is possible with the current vaccine. It is also more stable, flexible, easy to make, and easy to use, so producers can safely vaccinate their own herds.

The disease costs the United States $168 million annually in estimated production losses, herd quarantines, and regulatory program costs. More than 17.7 million cattle were blood tested and 8.8 million were vaccinated against the disease in the United States in 1986 alone. Currently, only about 48 percent of the test-eligible heifers in Texas are vaccinated because of the drawbacks of the USDA strain 19 vaccine; however, about 70 percent must be vaccinated to significantly reduce the incidence of the disease.

This new vaccine could save Texas and the Nation millions of dollars each year in regulatory program and herd health costs. If approved and marketed, the vaccine could be used extensively by cattle breeders and beef cattle raisers, thereby achieving favorable economic results for the cattle industry. Potentially, 10 million vaccine doses might be needed. The new vaccine could also reduce production costs and increase cattle marketability.

Infrared Spectroscopy Improves Wheat Marketing: The Federal Grain Inspection Service (FGIS) is evaluating a near-infrared spectroscopy method developed by ARS scientists to determine wheat classification by measuring protein and hardness. This method is faster and more objective than traditional methods, and would provide U.S. wheat breeders and growers with a competitive edge not available to countries such as Canada and Australia, which continue to regulate wheat within a very narrow germplasm base.

When applied to wheat, the historical terms "spring" and "winter" originally were used to distinguish types differing in growth habit and vernalization or fruiting requirements. However, these terms also have acquired a market definition which presumes a difference in end-use quality. Traditionally, these classes of wheat have been identified by the characteristic size, shape, and configuration of the kernel; however, crossbreeding between classes has made visual classification a less reliable method for determining these characteristics. As a result, the industry needs new definitions of the terms based on objective compositional and functional characteristics that are pertinent to end-use quality.

Extensive functional and compositional analysis of known wheat varieties indicates that protein and hardness are the two dominant characteristics useful for differentiating between spring and winter wheats. Protein and hardness, when determined by near infrared spectroscopy, will provide a rapid, objective means for classification that retains an orderly marketing system and meets the time and instrument requirements of FGIS. FGIS is currently testing and validating the concept on 10,000 samples of wheat.

Extension Accomplishments

Improving Water Quality: The USDA Extension Service (ES), and the Cooperative Extension System (CES), have increased emphasis on developing educational programs that address water quality concerns. These programs are designed to educate interested public audiences about the importance of the resource, the nature of contamination threats, the scope of the problem, and the implications to people.

As part of this effort, ES has identified water quality as a national priority initiative; released the report of a national task force on water quality; conducted a national workshop attended by 165 Extension professionals from 44 States; and developed a mechanism for continuing program leadership and guidance.

The Cooperative Extension System has also responded with educational programs and materials. More than 40 States are sharing program components which include computer programs, groundwater models, a groundwater simulator, video tapes, and displays. Model programs developed in 14 States are being presented throughout the system.

The Cooperative Extension System is actively involved in improving water quality. The Florida Extension Service has assisted in a major project to recycle municipal waste water, using it as a source of irrigation water for citrus groves. In Minnesota, a 3-county project assisted rural residents with well testing. Across all three counties, only 8 percent of the wells showed excessive levels of nitrate, and one groundwater supply had evidence of pesticide contamination. The Cooperative Extension Services in New York and Maryland have developed a series of slide-tape sets on the health effects of contami-

nated drinking water, water treatment methods, and testing and interpretation. These are being made available to Cooperative Extension representatives across the Nation.

Environmental Quality: The USDA Extension Service (ES) and the Cooperative Extension System (CES) are both engaged in efforts to improve the Nation's environmental quality. In cooperation with other Federal and State agencies and organizations, ES and CES provide educational and technical assistance to landowners, managers, producers, and urban clientele nationwide. Through these programs, participants learn to improve and sustain a strong and viable natural resource base in rural and urban communities; take advantage of opportunities to enroll highly erodible croplands in one or more of the available conservation programs; and comply with the conservation provisions of the 1985 Food Security Act.

The USDA Extension Service is working with the Environmental Protection Agency and the U.S. Department of the Interior to increase knowledge of where endangered species exist and to develop programs for strengthening protection of endangered species from potentially hazardous pesticides. Other programs teach clients to select and use pesticides and other agricultural chemicals in ways that reduce hazards to groundwater and surface waters and protect the safety of humans, domestic animals, and environmental quality. Extension encourages pesticide users to achieve more effective and economical applications and to consider the benefits of nonchemical alternatives. In related programs, participants examine alternative agricultural opportunities for profitable utilization of farm, ranch, and forest resources and learn about new technologies that can enhance environmental quality.

Specific examples include a program in South Carolina, where Extension brought together all major Federal and State conservation agencies to develop a State plan of work that improves protection of endangered plant and animal species from potentially hazardous pesticides. The Illinois Cooperative Extension Service, in cooperation with the Agricultural Stabilization and Conservation Service and the Soil Conservation Service, has developed methods for improving conservation compliance planning and implementation. Cooperative Extension Services in California, South Dakota, Washington, and Alabama, joining with other agencies and organizations, provided leadership in planning and conducting professional conferences on animal damage prevention and control. These conferences provided training for almost 1,200 professionals throughout the United States and internationally.

Virginia, Colorado, and Alabama Extension specialists, in cooperation with the U.S. Fish and Wildlife Service, developed and printed publications to help encourage implementation of the conservation provisions of the 1985 Food Security Act. These publications focus on the benefits of enrolling highly erodible lands and planting these lands to permanent vegetation to reduce soil erosion and chemical runoff, eventually improving fish and wildlife habitats, water quality, and environmental quality. These publications were disseminated to producers nationwide by cooperating agencies.

Pesticide applicator training was provided across the Nation by State Cooperative Extension Services to certify applicators and increase their knowledge of how to provide safer, more economical, and more efficacious use of pesticides. Such training increases the ability of

participants to prevent and control pest damage while concurrently reducing hazards to groundwater, natural resources, and the environment.

Innovative Marketing Techniques: Innovative marketing techniques are helping U.S. farmers develop the effective marketing strategies required in today's competitive environment. Evaluation of marketing alternatives is an essential part of these strategies, in addition to price forecasts, integrated financial plans, and adequate recordkeeping. Extension is conducting educational programs to assist farmers in evaluating marketing alternatives as well as supporting application of these techniques.

In Kansas, producer marketing clubs are providing hands-on experience for farmers who want to increase their ability to interpret market developments, become familiar with commodity futures markets, evaluate alternative marketing plans, and execute optimum marketing plans. Begun in 1984, these clubs have been established in more than 50 counties in the State. Club members provide $80 to $100 of their own funds to finance the club's market positions in two or more commodities. They meet regularly during the winter to evaluate progress and discuss alternatives. This interaction and real-life experience enhances the marketing skills of the participants.

Application of marketing techniques is occurring in Oklahoma, North Dakota, and other States through the innovative marketing of hay. The HAYMARKET program, developed by the Oklahoma Cooperative Extension Service and sponsored by the Oklahoma Alfalfa Hay and Seed Association, has been rewarding participants with higher prices for high-quality hay. Extension compiles and distributes listings of hay for sale and furnishes a HAYMARKET coordinator who assigns third-party graders to appraise and take samples of alfalfa being offered. The computerized marketing system links Oklahoma producers with buyers in 25 States. It enables buyers to locate the high-quality hay they need and provides producers a premium price not available through standard market contracts. Other innovative techniques, such as telemarketing, electronically link buyers and sellers of livestock.

Encouraging Careers in Agricultural Research and Education: Recent cooperative efforts within the U.S. Department of Agriculture have encouraged land-grant universities to expand efforts to interest pre-college youth in becoming scientists and educators. Because greater numbers of technologists in the food and agricultural sciences will be required in the 21st century, efforts are being made to counter declines at all degree levels in land-grant universities.

Efforts to encourage youth are occurring at many locations. An Extension model career development project being pilot tested at the University of Missouri and North Carolina State University emphasizes food and agriculture careers. The finished model will apply to many agricultural fields and will be made available throughout the Nation. At the Pennsylvania State University, Extension is conducting a USDA-funded effort to identify the instructional strategies most effective in developing positive attitudes toward science and technology.

The University of Wyoming is developing model food and agricultural 4-H projects with greatly enhanced scientific content and opportunities. Resident instruction, research, and Extension are cooperating in this project, which is funded by USDA's office of Higher Education Programs.

Florida State University is exploring ways of offering secondary school or college credit for intensive, self-determined 4-H science-related projects which are done in conjunction with a "mentor" who is a working scientist or technologist.

In 1988, 17 land-grant universities were educating 452 outstanding secondary school students on their campuses through "Young Scholars" programs funded by the National Science Foundation. Ten of these projects concentrate on life sciences and agriculture. Participants work one-on-one with researchers, study careers, and engage in year-round at-home followup in their schools and 4-H programs. Resident instruction, research, and Extension are cooperating in most of these efforts.

The University of California has been granted resources by the National Science Foundation for a project that uses teen volunteers to improve young people's science proficiency. The project will be made available for nationwide adoption. In Michigan, 4-H and the Ford Motor Company have established a partnership to strengthen the high-technology experiences provided to 4-H youth and leaders. Other States, including Nebraska, have enjoyed great success with special events held on their campuses specifically for college-bound youth. The "Biology Career Program" in Nebraska trained youth on campus in summer, then used these teens to work with youth in 4-H projects including veterinary science, animal science, agronomy, food science, forestry, fisheries, wildlife, and entomology.

Coordinate National Nutrition Information: Increased public concern on nutrition and health information requires dissemination of research-based educational information to a more diverse audience than Extension's past traditional audiences. The USDA Extension Service, the American Council of Life Insurance, and the Health Insurance Association of America joined forces to develop a manual on worksite wellness. It is a guide to employers in providing cost-effective wellness programs for the American workforce. Approximately 15,000 copies were distributed nationwide to USDA, other government agencies, private industries, and the medical profession.

Many American consumers consider food safety their major concern. A recent survey reported over 3 million calls to Extension staff in 1986-87 concerning the safety of food products. Extension has increased educational outreach to professionals and food handlers. These programs target audiences with the greatest need, including small businesses, government, and industry groups, and provide current information on known problems concerning food safety and related subjects. Extension volunteers instructed more than 135,000 people in food safety last year.

Computers Help Integrate Cropping Systems: Crop producers are now being provided with integrated information, record systems, and computer software that enable them to more adequately evaluate and implement research-based crop production information and sound business practices. In Iowa, Extension is using interdisciplinary teams to provide corn and soybean farmers with information that enables them to improve their crop management decisions. A crop enterprise record system, piloted in 1986 and revised in 1987, allows producers to calculate their economic and production efficiency on a field-by- field basis. Last year, interest by crop producers in the research-based information resulted in over 22,000 one-on-one contacts and attendance of an additional 23,000 producers at crop

production efficiency meetings. Surveys of participants in similar, but less integrated, programs in 1984 and 1985 showed that yields increased slightly and costs of production were significantly reduced.

In Kansas, Cooperative Extension has developed integrated software for microcomputers that models the ways farmers plan their crop production. The Corn Management Systems and the WHEATpro model incorporate modules on major decisions growers face. This includes hybrid selection, tillage practices, planting details, weed and insect control, and harvest practices. Extension agents trained in the use of the crop management systems assist producers in using the models at county offices. This project, initially supported partially by the W. K. Kellogg Foundation, is now being extended through sharing agreements with other State Extension Services.

Job Creation and Services in Rural Communities: Cooperative Extension efforts aid rural economic development by increasing jobs, improving incomes, and strengthening community facilities and services. Extension programs include small business management, community economic analysis, industrial development, community decisionmaking, retention and expansion of existing businesses, and plant shutdown and worker displacement assistance. In recent years, Extension programs worked with more than 100,000 individuals and nearly 2,000 downtown businesses to improve 50 downtown areas, resulting in the creation of an estimated 40,000 jobs. Even more jobs were retained through Extension education programs aimed at existing businesses.

Last year, Extension helped thousands of local officials and volunteers to provide a broad range of community facilities and services to needy communities. These assistance projects included community multi-purpose centers, nutrition feeding sites, farmers' markets, community water systems, and fire protection. Other programs assisted with manpower development and employability skills, housing, services for older residents, rural crime prevention, solid waste management, small farm production and marketing, and rural development policy.

Specific instances where jobs were created include an effort in a southwest Georgia county which resulted in a $10 million investment that will put 200 local people to work. In New York, Extension specialists in biotechnology transfer worked actively with nearly 110 small entrepreneurial firms. A Tennessee rural development committee, chaired by Extension, investigated a number of alternatives for creating jobs and income. In an area of central Pennsylvania that was faced with high unemployment, Extension conducted a needs assessment before starting a program on how to start and manage small businesses.

In the community services area, Extension programs in Indiana helped establish four health clinics and attract the necessary doctors. Training and assistance were provided for starting 11 home-based daycare centers in Georgia and to over 400 geriatric health care professionals in Missouri. Elsewhere, community water systems were established or expanded in rural areas, fire service was extended, low-income housing units were developed, and sewage and solid waste handling districts were established.

Programs for Youth: Nationally, 4-H collaborates with other public and private agencies to prevent drug and alcohol abuse, reduce suicide by building youths' self-esteem,

preparing young people to make responsible decisions about their sexuality, and reducing the school dropout rate by forming alliances with public school systems. Extension's 4-H youth programs involve a large percentage of rural youth in both innovative and long-established activities. Leadership development training prepares youth to participate in community planning, respond to family needs, contribute solutions to social and economic opportunities, develop small businesses, and learn transferable job skills.

Missouri and California Extension staffs are organizing after-school child care programs, with plans to expand to new locations. The program cooperates with school systems, involves parents, complements the formal school program, and provides an environment for completion of homework assignments. The results of these programs show that the students are more enthusiastic about school and are engaged in positive experiences rather than going home to empty houses without parental supervision.

In Indiana, Extension staff deliver educational programs to young teen mothers about proper infant nutrition, care of infants, home budgeting, and other critical skills required in being a successful parent. The program also focuses on the needs of the teen mother, including balancing parenting with completing school, seeking employment, and becoming self-sufficient. This effort is delivered through volunteer "moms" who commit three personal visits per month for a year to the teen mother. This successful program is in its fourth year.

New York and North Carolina Extension staffs are conducting successful programs that involve older youth working with younger children. New York teens trained in "Make Up Your Mind About Alcohol" reached thousands of younger children with information concerning the effects of alcohol consumption on the body and health. North Carolina's TRY (Teens Reaching Youth) program reaches many youth with information about current issues and gives teens important roles in their communities.

The number of teen and adult volunteers working with the Extension 4-H youth program continues to grow, reaching 622,514 in 1987. Approximately half the 1,588,469 youth participating in 4-H clubs are involved in volunteer work through community service projects, fund-raising, and peer assistance. New models for enhancing volunteer development have been developed in cooperation with the National 4-H Council and with funding from the Kellogg Foundation. The models focus on teaching the volunteer ethic to youth, strengthening boards and committees, and empowering volunteers to enhance their effectiveness. States included in this model development include Alaska, Colorado, Indiana, Kentucky, Nebraska, New York, North Carolina, and West Virginia. Fifteen additional States are replicating these models.

Meeting Family Needs: Extension educational programs are meeting the concerns of American families in several critical areas. One group of programs assists military families who face the additional stresses of mobility, separation, and changing social environments. In 1986, the U.S. Department of Agriculture and the Department of Defense signed a Memorandum of Understanding to foster cooperation between the Cooperative Extension System and the military services. Extension staff provide cooperative programming in financial management and family support at more than 60 military

installations across the country. Funding for these educational programs comes from contracts between the military installation and various State Cooperative Extension Services.

Extension educational programs on effective parenting skills and prevention of child abuse reached 693,537 parents through direct contact and another 9 million parents through the mass media. Many programs were targeted to high-risk parent groups. In a Guam Teen Parenting Project, 71 percent of teen parents either graduated from high school or continued in school. Ninety-two percent of the infants of the teenage mothers were receiving regular health care. In New York, 22,708 adolescents participated in classes designed to provide teenage parents with independent living skills. Low-income families were the focus in Georgia, and a home learning program for new parents was translated to Spanish to meet the needs of an increasing number of Spanish-speaking clientele.

Economic uncertainty, high divorce rates, and the growing number of dual-employed families place added stress and strain on America's families. In 1987, through Extension programs, more than 542,433 people learned effective ways to cope with stress. A study of participants indicated that 81 percent had learned new ways to deal with stress and 63 percent had changed their behavior in a positive direction. An additional 22 million learned of effective coping strategies through mass media educational contacts.

Extension also conducted programs to improve the quality of life for the over 9 million elderly and their caregivers. Missouri Extension (with a grant from the Administration on Aging) and the Missouri Extension Homemakers Council developed, tested, and piloted a Volunteer Information Provider (VIP) program in four rural counties. As a result of these pilot efforts, 20 States are now conducting the program. Volunteers are trained to go into the homes of the rural elderly and provide information on diet, nutrition, health, and community resources. To date, 380 VIP's are working in 40 counties in 17 States. Over a 2-month period, these volunteers reached 2,200 caregivers and contributed 10,000 hours of their time. Because of the success of the pilot effort in Arkansas, State monies have been allocated to extend the VIP program into every county.

National Cooperative Dairy Herd Improvement Program Handbook: The National Cooperative Dairy Herd Improvement Program (NCDHIP) is one of the oldest and most successful education/research programs of USDA. It involves the USDA Extension Service and Agricultural Research Service as well as the Cooperative Extension Service in every State. Service aspects of the program are carried out by Dairy Herd Improvement (DHI) organizations of farmers at the local, State, and national levels. National and State memorandums of understanding delineate the responsibilities of each group and empower a policy board to set policy for this industry-wide cooperative program.

The NCDHIP was an innovator in adopting a systems approach to production management. Extension provided leadership for the development of an NCDHIP Handbook to bring together in one publication all of the pertinent information related to organizations, committees, rules, standards, field service, laboratory and computing routines, statistics, and use of records in education and herd management. Over 180 persons from 50 States or territories, with 80 from the private sector and 100 from the public sector, were involved in developing the material.

A national subscription list is maintained and twice-a-year updates, which include USDA-Agricultural Research Service sire and cow evaluation research results, keep all persons involved with the program current on new developments, information, and technologies. Editing and publication are handled by the University of Maryland, subscriptions and mailing by the National Dairy Herd Improvement Association. This perpetually updated information resource is maintained on a self-supporting basis, representing effective cooperation among the public and private sectors.

Energy Programs: The Cooperative Extension System has a long history of cooperation with others in developing energy-related programs, working first with the Federal Energy Administration and now with its successor, the Department of Energy (DOE). Cooperative Extension Services began incorporating energy situation and management information into their programs at the time of the oil embargo of 1973. Programs were expanded when funds from the DOE were transferred to Cooperative Extension Services for development of demonstration projects including use of solar energy for heating livestock structures and for drying field crops. States have received energy grants to implement the DOE Extension Service outreach program for more than 10 years. Oregon, Mississippi, and Florida continue to administer this DOE program; Massachusetts and other States administer portions of it.

During the past year, some State Cooperative Extension Services have obtained Oil Overcharge Funds reimbursed to the States for developing energy-related programs. New York State received funding to operate a small business audit program which includes agriculture. Minnesota has received funding to develop a cold-climate housing research and outreach program, and Iowa has implemented an energy/water management program and a housing program. Alabama has funding to conduct Agricultural Energy Education programs; additional State proposals are awaiting approval. More than half of the States receive some funding for energy educational programs. The amount of funding is usually $12 to $14 million annually.

Each October, the Cooperative Extension Service participates in an "Energy Awareness Month" campaign sponsored by government agencies and the private sector. Approximately 6,500 resource packets are prepared annually for distribution to States and counties. Reports from 140 counties indicate that nearly 4.9 million people were reached last October through energy tours, meetings, media efforts, and publications. This information leads to more effective energy management and the use of alternative renewable forms of energy that reduce energy costs for farmers, the residential sector, and communities.

Higher Education Accomplishments

Improvements in Agriculture and Natural Resource-Related Degree Programs: Improvements in curriculums and organization of degree programs are necessary to better prepare students for their future educational and work-related needs. The College of Agriculture and Home Economics at Washington State University, the Washington State Department of Agriculture, the Washington State Department of Adult and Youth Education, and the State Superintendent of Public Instruction cooperated to develop an inservice educational program conducted simultaneously at several locations through the facilities of the Washington Higher Education Telecommunication System. The program, for secondary and post-secondary agricultural teachers, focused on the agricultural curriculum that will be needed as the 21st century approaches.

The College of Agriculture and the Department of Business Administration at the University of Illinois established a joint program in which a student may complete a Bachelor of Science degree in an agricultural science and a Master's degree in business administration. This not only better prepares the agricultural student to enter an agriculturally related business, but does so in 5 years, rather than the 6 or 7 usually required. At Washington State University, discussions with agribusiness employers led to an agribusiness degree program that includes agricultural economics and business administration courses, providing business and agricultural skills sought after by agribusiness firms.

Cook College at Rutgers University modified graduation requirements to make available a "Professional Practices" component that permits students to work in private-sector jobs. "Individual learning contracts" are established by the individual student, an academic advisor, and a representative from the business offering the professional practices opportunity. These work-related experiences supplement campus-based studies in agriculture, home economics, veterinary sciences, and forestry.
Two new Master's degree programs were developed at the School of Agriculture, California State Polytechnic University-Pomona. Collaboration between the Department of Agricultural Business Management and the Department of Urban and Regional Planning led to a Master's degree in international development. The second new Master's degree program—in interior architecture—was developed by the Departments of Architecture and Environmental Studies and Home Economics.

Academic Programs Workshop: The College of Agriculture and Life Sciences at North Carolina State University, recognizing the influence of high school science teachers on the curriculum and career choices made by high school students, has embarked on a program to provide teachers with information about academic programs and research activities in the College. A 2-day on-campus workshop in February 1987 had 33 participants; this year, 46 people attended.

The workshops provided the teachers a variety of learning experiences using research and teaching faculty from animal science, biological sciences, botany, food science, genetics, horticulture, poultry science, soil science, and zoology. Teachers received academic literature; lesson plans; and laboratory exercises in food science, soil science, and botany (including plant material) for use in their high school courses. A similar "Science Expo" at Ohio State University attracted 68 teachers in its first year (1985); 400 teachers attended, including 250 high school science teachers. The Ohio State "Expo" features a science workbook that includes outlines for over 50 projects designed for middle and high school. The teachers also received information on environmental research (acid rain), aquatic research, use of new concepts in the reproductive physiology of domesticated livestock, and innovative techniques for improving disease resistance and reproductive performance in poultry and flavor in meat products.

The teachers who participate in these programs become knowledgeable about the breadth of the curriculums and the variety of research in the colleges and become better informed about the variety of opportunities for graduates. The teachers reported that they used much of the material in their classes, especially the lesson plans and laboratory exercises. The continuing association that has developed between college faculty and high school teachers will further enrich the high school science learning experience. Ideally, it also will lead to increased enrollment of outstanding science students in colleges of agriculture.

Animal and Veterinary Sciences Collaborate: Meeting "real-world needs" and solving "real-world problems" are the goals of a new collaboration between animal science and veterinary science departments at Iowa State University. "Production Medicine" is the name given to an elective track available to select fourth-year professional curriculum students in the College of Veterinary Medicine. Introduced during the 1987-88 academic year, this block of study provides a multidisciplinary program to orient students to whole-herd preventive medicine. It builds upon students' previous background in livestock production as well as their education in animal science and veterinary medicine. The students are taught to direct preventive medicine toward health care delivery to a population rather than to individual animals, resulting in cost-effective health care as well as production efficiency in the livestock unit.

The 12-week block includes 40 contact hours of laboratory. In the mornings, students complete clinical rotations in Theriogenology, Food Animal Medicine and Surgery, and Veterinary Field Services. Afternoons are devoted to lectures and applied preventive medicine laboratories. Multidisciplinary cooperative programs such as "Production Medicine" appear to be a realistic way to provide enhanced educational experiences with limited financial inputs.

Combating Wildlife Diseases: A unique educational opportunity exists for University of Wyoming students interested in the study of wildlife diseases. The Department of Veterinary Sciences has a national reputation for its work, especially in the area of diseases transmissible between domestic and wild animals. Several university, Federal, and State agencies cooperate in these teaching and research activities. Cooperation with the Wyoming Game and Fish agency, U.S. Fish and Wildlife Service, USDA-ARS, USDA-APHIS, and other departments at the University of Wyoming ensure a balanced educational opportunity for students pursuing a master's degree in pathobiology.

Areas of emphasis include pathology, bacteriology, virology, mycology, immunology, and parasitology. Examples of recent research and teaching projects include canine distemper, virus infections in wild black-footed ferrets, and transmission of an arthritis-causing microorganism between domestic and bighorn sheep. The result of this cooperative effort is a high-quality cross-discipline educational experience for students with a wide variety of agricultural interests. Of major importance is the opportunity that the program provides for students to work on cross-discipline/cross-species problems.

Genetics and Biotechnology: There has been a dramatic and unprecedented escalation in need for baccalaureate graduates in the area of genetic engineering with a molecular understanding. The national need has been thoroughly documented by reports from the U.S. Office of Technology Assessment, the USDA Joint Council, and private groups. The evaluations agree that it will be virtually impossible to meet the business and industrial needs for persons trained in molecular genetics over the next 10 to 15 years. At Texas A&M University, the undergraduate program in biochemistry is experiencing an explosion in enrollment from 140 in 1981 to more than 420 in 1986. However, the area of interest has changed from the traditional biological science to the newer areas of biotechnology. Undergraduate students in agriculture and the related biological sciences are demanding greater scientific depth in their education, particularly in the area of biochemistry and genetics.

The new genetics program at Texas A&M substitutes biological and genetic coursework for some of the more detailed quantitative and physical sciences in the biochemistry program. In addition, it introduces in-depth coursework in genetic systems which can be individually directed for each student. The local and regional needs for this program range from a requirement for technical assistants throughout the Texas college and university system and surrounding biomedical institutions to personnel requirements of the many emerging biotechnology companies that have begun to move into Texas.

The educational objective of the undergraduate program in genetics is to prepare students for entry into the emerging technologies of genetic engineering and biotechnology as well as into the more classical agricultural and biomedical applications. Students receive thorough preparation for post-baccalaureate education in agriculture and its related biological sciences (such as genetics, plant or animal breeding, physiology or biochemistry, and specific plant or animal sciences). The program also prepares students to pursue biomedical and veterinary medical studies, because the curriculum provides a strong background in the basic sciences (biology, chemistry, mathematics, and physics). This course of study will provide technological understandings of genetics which are applicable to new directions in biotechnology and thus may provide direct opportunities in industry. It can also lead into graduate or professional training for a business/law career based on the use of biotechnology in the industrial environment.

Accomplishments of the Joint Council, National Committees, and Regional Councils

Throughout the year, the Joint Council, the National Committees, and the Regional Councils met to develop and review material for inclusion in this report as well as the other Council reports. The following is a summary of the major elements of their accomplishments and activities.

Joint Council on Food and Agricultural Sciences

Fiscal Year 1990 National Priorities: The Joint Council, with involvement from its National Committees and Regional Councils, selected and ranked national priorities for research, extension, and higher education programs. State, regional, and national perspectives were taken into consideration during the selection process.

The priorities report addresses four overarching societal concerns:
- Advancing food and agricultural expertise
- Enhancing the competitiveness and profitability of the food, agriculture, and forestry sectors
- Revitalizing rural America
- Improving the economic stability and well-being of families.

The five national food and agricultural science and education priorities ranked for fiscal year 1990 were:
1. Improve water quality and quantity
2. Expand biotechnology and its applications
3. Maximize human capital to advance food and agricultural science and education
4. Improve understanding of diet, human nutrition, and health relationships
5. Genetically improve economically important plants.

Major Activities: The Joint Council gave particular attention to several major issues and topics during the past year:
- New approaches to enhance agricultural biotechnology
- EPCOT Center--The Land
- Assessment of the 1988 *Five-Year Plan for the Food and Agricultural Sciences*
- Forestry education, extension, and research: issues and challenges
- Changing directions in trade and agriculture policy
- National Extension initiatives
- Sustainable/low-input agriculture
- The future of American agriculture and implications for the food and agricultural sciences
- The produce industry: an overview
- Agribusiness management options
- Marketing and product development.

Future Directions and Activities: The Council gave special consideration to determining the most appropriate mission and scope for its future activities. Members decided to increase emphasis on strengthening the coordination, planning, and facilitation roles of the Council and on identifying emerging issues that affect the food and agricultural science and education system.

A special report entitled *Continuing the Momentum: History, Growth, and Future Challenges* was prepared and distributed to the Joint Council members. The paper outlines the background, growth, and future of the Council. It provided the basis for the discussion of future areas of emphasis. They are:

- Broaden the base of input for planning, coordination, and definition of problems.
- Expand the distribution of Council reports and other documents to improve public understanding of the societal benefits of research, extension, and teaching.
- Enhance congressionally mandated reports by preparing and distributing additional information.

The report will be published in December 1988.

Accomplishments of the National Committees

National Agricultural Research Committee: The National Agricultural Research Committee (NARC) reviewed and revised the research priorities for the coming year, bringing together ideas from the more than 140 State and Federal units engaged in research and from industry. Twenty-one priorities were identified for the Joint Council; the highest priority items were included in the 1990 priorities report. The development of the NARC consensus on research priorities is based on interfacing well-developed plans from the State Agricultural Experiment Stations and the Agricultural Research Service and other Federal research agencies, along with plans from Forestry, Home Economics, Veterinary Medicine, the Evans-Allen institutions, and the non-land-grant institutions. In all cases, there is rich input from users of agricultural research and technology to these component plans.

The NARC noted a shifting emphasis of its constituent members to concerns about food safety and diet-health issues and concerns related to sustainable agriculture. Systems science applied to agriculture is becoming a pervasive component of agricultural research. Concerns about water quality and quantity occupy top priority in the view of NARC. Biotechnology continues to offer major opportunities to make conceptual breakthroughs in the sciences basic to agriculture.

The NARC revised methods for soliciting and reporting research accomplishments, introducing the concept of long-term accomplishments to provide a better perspective on the achievements of the system.

National Extension Committee: U.S. agricultural competitiveness and trade policies were examined by the National Extension Committee in 1988. Speakers Robert Thompson and John Dunmore highlighted the importance of understanding world markets; the influence of macroeconomic policies on trade; and the critical importance of research and development in enabling U.S. producers to be competitive in world markets.

The Committee examined the role of youth development programs in providing experiences and environments where youth can grow. Beneficial experiences provided through 4-H clubs and related activities help youth develop self-esteem and deal with drug abuse and other problems. Programs for youth must capitalize on the land-grant system for a research base, and this system must act as a resource to all youth organizations. The Committee recommended that youth programs be given a high level of importance in future programming.

The Committee received special reports on the ECOP Futures Task Force findings and recommendations, Extension system budget activities, and the Northeast Regional Council's "Toward 2005" project. In September, the members visited the large farm of Jim and Kathy Moseley near Purdue University, where they discussed Extension's roles with large-scale agriculture and in agricultural communities.

The Committee received regular reports throughout the year on activities within the USDA Extension Service, the Joint Council, the Users Advisory Board, the Sea Grant Program, the National Agricultural Research Committee, and the National Higher Education Committee. In March, the Committee voted to include a representative of the Association of Administrators of Home Economics among its membership. Julia Miller, Dean of the College of Human Ecology, Michigan State University, is the new member representing that group.

The Committee contributed regularly to Joint Council reports. Extension priorities for fiscal year 1990, submitted in March, are consistent with the eight national initiatives being developed within the Extension system. Examples of both long-term and short-term accomplishments were submitted for consideration for the Joint Council's 1988 accomplishments report. Issue statements and resource projections have been prepared for the five-year plan.

Issues planned for consideration during the coming year include: (1) Extension's national initiatives, including strategic planning and issues programming, (2) nonbudget legislative affairs that affect Extension, and (3) emphases and priorities identified in fiscal year 1988-91 plans of work recently developed by State Cooperative Extension Services and the USDA Extension Service.

Accomplishments of the National Higher Education Committee: The National Higher Education Committee met three times during the past year, focusing on its primary mission of identifying major issues confronting higher education and recommending alternatives by which those issues can be successfully addressed.

One major effort dealt with assessing numerous higher education priorities and submitting five to the Joint Council for consideration as material for the fiscal year 1990 priorities report. The priorities submitted were: faculty development, modernization of instructional equipment, expansion of undergraduate research opportunities, enhancing the National Career Information System, and expanding the Doctoral Fellowship Program. The Committee also identified 10 high-priority issues and items on which they plan to concentrate their future efforts. A number of higher education accomplishments, both long-term and current, were submitted and accepted in the Joint Council's 1988 accomplishment report.

Several speakers addressed the Committee on such subjects as assessments of educational outcomes; ethics and decisionmaking in the undergraduate curriculum; and the first of a number of sessions examining the current state of curriculums within the colleges and schools of agriculture, forestry, home economics, and veterinary medicine.

Accomplishments of the Regional Councils

Western Regional Council: As part of the Joint Council's priority-setting process, the Western Regional Council met in February 1988 to develop the 1990 priorities for the Western Region. Based on input from the Western Agriculture Research Committee, the Western Extension Committee, and the Western Higher Education Committee, the Council identified 63 priority areas for future emphasis. The group also identified the unique characteristics of the West which affect the priority areas. The highest priority was placed on protecting the quality and increasing the supply of water. In addition to its annual meeting, the Council participates in meetings of the Western Regional Forum.

Northeast Regional Council: The Northeast Regional Council completed the study "TOWARD 2005: Issues and Opportunities, Northeast Agriculture, Food, and Forestry." This future-oriented study published with the financial support of the Northeast Regional Center for Rural Development and Agway Inc. resulted in five publications: Baseline data and projections; Issues and opportunities in agriculture and food; Issues and opportunities in forestry; The land-grant system; and a consolidated report.

The Council, again in cooperation with the Northeast Regional Center for Rural Development, held a 2-day forum called "Toward 2005: The Northeast Food System, a Focus on Dairy." The purpose was to evaluate the regional dairy-related issues identified in the overall Toward 2005 project and to develop a strategy to address those issues. Nearly 100 attended the meeting and participated in one of six sessions. The results of the individual sessions were published as a proceedings (available from the Joint Council). A standing Dairy Leadership Group has agreed to follow up on the workshop recommendations.

Future forums are planned in those areas where a regional discussion of issues would benefit Northeast agriculture, food, and forestry. The forestry committee of the Toward 2005 Task Force II is planning to conduct a forum on forestry issues to address the action agendas noted in the forestry report.

Appendix A: The U.S. Food and Agricultural Science and Education System

Cooperative State Institutions:

- Land-grant colleges or universities in each State, as authorized in 1862, plus 16 colleges of 1890 and Tuskegee University, have programs of higher education in the food and agricultural sciences.
- Fifty-eight State agricultural experiment stations (many with networks of substations), plus 17 schools of forestry, and certain schools of home economics and veterinary medicine conduct research programs partially supported by Federal formula funds. Research investment (all sources) was $1.4 billion in FY 1987 involving approximately 7,800 scientist years (SY) of research effort. (The number of universities involved and the various accounting systems employed by them prevented a FY 1988 recapitulation of expenditures by the time this report was published.)
- Cooperative Extension Services exist in all 50 States plus the District of Columbia and U.S. territories. With total funding at approximately $1.1 billion, Cooperative Extension programs involved about 15,000 professional staff years, plus almost 3,500 paraprofessional staff years and significant contributions by nearly 3 million volunteers trained and supervised by professional extension staff.

USDA Research and Education Agencies:

- The Agricultural Research Service allocated nearly $540 million in FY 1988. Research is conducted at 125 locations in the United States and abroad involving 2,650 SY's.
- The Cooperative State Research Service is the agency of the USDA through which Federal research funding for the States is channelled and coordinated on behalf of the Department of Agriculture, in cooperation with all of the State and Territorial Agricultural Experiment Stations, Colleges of 1890 and Tuskegee University, forestry schools, colleges of veterinary medicine, and other cooperating institutions. The FY 1988 funding level for CSRS was $352 million. This included $42.4 million for the Competitive Research Grants program, $42.5 million for facilities at the land-grant institutions, and $7.6 million for higher education programs.
- The National Agricultural Library, funded at $12.1 million in FY 1988 and involving 190.8 SY's, provides wide-ranging library and technical information services.
- The Economic Research Service, with funding of $48 million for FY 1988, accounts for 383 SY's of economic and social science data collection, research, and analysis.
- The Forest Service research divisions, with about $133 million in funding (including $6.0 million in support of a Competitive Forestry Research Grants Program) in FY 1988, provided about 713 SY's of research in resource management and utilization and in resource protection efforts.
- Other USDA agencies have limited but direct research and education roles:
  - Office of International Cooperation and Development
  - Soil Conservation Service
  - Agricultural Marketing Service
  - Office of Transportation
  - Agricultural Cooperative Service
  - National Agricultural Statistics Service
  - Human Nutrition Information Service

Other Colleges and Universities:

- Approximately 200 other State-supported colleges or universities, including 65 with baccalaureate degree programs, conduct programs of higher education, research, and outreach in the food and agricultural sciences.

Other Federal Agencies:

• At least 14 Federal departments, commissions, and independent agencies besides USDA conduct research and education programs closely related to agriculture and forestry or provide funds to support programs in the USDA-State system. These include:

Department of Health and Human Services, through National Institutes of Health
Department of the Interior
Department of State, through the Agency for International Development
Department of Commerce
National Science Foundation

Private Firms:

• Research and development (R&D) are performed by equipment, seed, fertilizer, and other input suppliers; processors of food and fiber; and specialized private R&D firms. A July 1985 survey published by the Agricultural Research Institute estimates private sector annual research expenditures of about $2.1 billion.

• Field personnel and information specialists employed by vendors of food and agricultural supplies, equipment, and services disseminate technical information to farmers and to processors and distributors of agricultural commodities. Consumer service departments of most major food processors develop and deliver a wide variety of nutritional and technical information to consumers. Agriculture-related publications, as well as radio and television, provide timely information which is widely used by those who engage in food and fiber production and processing and is of interest to many consumers as well.

Other Private Organizations:

• Foundations and similar organizations facilitate or channel funds to research and/or education for the public good.

• Associations formed by private firms conduct research and/or educational programs for their members.

• Professional organizations and societies publish scientific papers and provide forums where agricultural research knowledge is disseminated and discussed.

Appendix B: Members of the Joint Council on Food and Agricultural Sciences

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Dr. Kenneth R. Bolen (Vice-chair)
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Northeast Regional Council:

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